Appendix B

Corps and TVA Reports and Evaluations Used in FSEIS

1. Waterways Experiment Station Report, " Plan C – Spillway Training Works, Kentucky Lock & Dam Model", by Randy McClollum (11-9-00). Also, Figures Showing Nine Foot Draft Velocity Vectors For Base, Plan B-2 (with Navigation Training Dike) and Plan C (with Spillway Traning Dikes). Six Flow Conditions per Plan.

2. TVA Norris Hydrologic Engineering Laboratory, " Kentucky Lock, Impacts of New Lock on Tailwater Mussel Beds", by Jerry Schol (12-1-00).

3. Section 404(b)(1) Evaluation, Corps of Engineers, Nashville District, PM-P, by Tim Higgs (5-8-01).

4. Corps of Engineers Letter by Don Getty (dated 11-17-00) and Memorandum For Record, "Temporary Fill for Placement at Taylor Park Campground", by Benjamin L. Rohrbach, 11 November 2000.

5. Corps of Engineers Memorandum for Record, " Subject: Water Surface Elevation Impacts Due to Placement of Training Structures In KY Dam Tailwater", by Benjamin L. Rohrbach, 12 January 2001.

6. Corps Memorandum for Record, " Subject: Impacts to Headwater and Tailwater Flooding Due to Proposed Features of Lock Addition", by Benjamin L. Rohrbach, 10 January 2001.

7. Corps of Engineers Letter by Don Getty (dated 9-15-00) and Proposed Compensatory Wetland Mitigation Plan Benton, Kentucky. Also, Kentucky Division of Water Letter from Edward Carroll, dated 10-15-00, acknowledging assurance that mitigation will be completed.

(ITEM 1) PLAN C – SPILLWAY TRAINING WORKS

KENTUCKY LOCK & DAM MODEL

After completion of design and evaluation of training works to improve navigation in the lower lock approach with the proposed 1200 ft lock (Plan B-2), the model was used to develop training works in the spillway below the dam (Plan C). These training works were developed to reduce the size and strength of an eddy that forms at a 100,000 cfs flow condition and also improve flow mixing from the spillway and the powerhouse tailrace. The Kentucky Department of Fish and Wildlife representatives established the 100,000-cfs flow condition as being the most critical in reducing the eddy size and strength. This flow condition has maximum powerhouse flow and the three spillway gates adjacent to the powerhouse open. When there are more spillway gates opened, recreational boaters remain well away from the spillway. When there are three gates or less open, boaters are restricted to stay only a few hundred feet from the spillway. The eddy that forms with the 100,000 cfs flow condition without any training works extends downstream from the spillway considerably farther than this and produces flow moving upstream along the left bank and across the spillway toward the open spillway gates. There have been reported cases of boaters drifting in this eddy and being pulled back into the spillway.

To develop the training works in the spillway for Plan C, the model was left in the Plan B-2 configuration (Powerhouse Island training work to improve navigation conditions in the lower lock approach) and the 100,000-cfs flow condition was set. Temporary training structures (in this case, bricks) were placed and evaluated for their effectiveness in reducing the size and strength of the eddy. For visualization, dye and confetti were placed in the model and observed to determine how various placements of these temporary training works influenced the size and strength of the eddy. The height of the training works was set not to exceed the height of the old railroad piers, El 295.0. The position, length, angle to flow, and number of structures was varied until a combination was achieved which provided the most reduction to the size and strength of the spillway eddy for the 100,000 cfs flow condition. The temporary training works were removed and typical side sloped dike structures were fabricated using the position, length, elevation, and angle derived from the temporary structures. The model was again set up with the 100,000-cfs flow conditions and the eddy visualized with dye and confetti. Adjustments were made to the position and angle of the side sloped training works until the model replicated the dye and confetti patterns noted with the temporary training works. No current directions or velocities were obtained with the temporary training works in place. The final positions, lengths, elevations, and cross-sections of the spillway training works developed for Plan C are shown in Figures 1 – 4.

To evaluate how the installed spillway training works would affect the eddy in the spillway and navigation conditions in the lower lock approach, the model was operated with six flow conditions:

Discharge, cfs	Upper Pool El, ft.	Lower Pool El, ft.
35,000	359.0	300.0
79,000	359.0	303.6
100,000	358.0	306.3
155,000	359.0	316.0
300,000	362.5	328.0
370,000	368.3	344.0

Current directions and velocities were collected and tow operations performed and recorded for each flow condition. Current directions and velocities and the tow tracks for Plan C were then compared to those collected for Plan B-2 to determine the effect of installation of the proposed spillway training works.

CURRENT DIRECTIONS AND VELOCITIES

35,000 cfs – The eddy in the spillway for Plan C (Figure 5) is smaller, is slower, and does not extend as far downstream as that of Plan B-2 (Figure 6). The velocities off the end of the Powerhouse Island training dike are slightly reduced with Plan C versus Plan B-2 and the eddy in the lower lock approach for Plan C is smaller and slightly slower than with Plan B-2.

79,000 cfs – The eddy in the spillway for Plan C (Figure 7) is somewhat smaller than that recorded with Plan B-2 (Figure 8). Instead of two relatively large eddies in Plan B-2, there are three smaller eddies in Plan C. The largest eddy in Plan C does not extend upstream to the spillway as does the eddy in Plan B-2. The eddy velocities for Plan C are slightly reduced as compared to those of Plan B-2. The velocities off the end of the Powerhouse Island training dike are the same or slightly higher with Plan C versus Plan B-2 and the eddy formed in the lower lock approach is slightly larger for Plan C than for Plan B-2, but is approximately the same velocity.

100,000 cfs – The eddy in the spillway for Plan C (Figure 9) is confined to upstream of the proposed highway bridge as compared to extending downstream of the proposed railroad bridge by up to 300 ft for Plan B-2 (Figure 10). The velocity of the eddy for Plan C along the left bank just upstream of the proposed bridges is 1.3 fps as compared with 3.4 fps at the same position with Plan B-2. The velocity of the eddy crossing the spillway with Plan C is about 1.5 fps as compared with 2.7 fps near the same position with Plan B-2. A small counter-clockwise eddy still exists downstream of the proposed bridges with Plan C, but it is confined to well downstream of the proposed bridges and is completely disconnected from the large upstream eddy. The velocities off the end of the Powerhouse Island training dike out into mid-channel are higher for Plan C compared to Plan B-2. Along the left bank, from the proposed bridges down to near the proposed left bank fish jetties, the velocities are lower with Plan C as compared with Plan B-2. The velocities are approximately the same for both plans after passing the proposed left bank fishing jetties, which are approximately 4000 ft downstream from the axis of the dam. The eddy in the downstream lock approach is larger and has a higher velocity for Plan C as compared with Plan B-2. This eddy is downstream of the lower end of the proposed guide wall.

155,000 cfs – The eddy in the spillway for Plan C (Figure 11) is only moderately different than that with Plan B-2 (Figure 12). The eddy in both plans are approximately the same size, but it appears that the velocity of the eddy with Plan C may be slightly less than with Plan B-2, especially near the left bank spillway abutment wall. The velocities off the end of the Powerhouse Island training dike are almost unchanged with Plan C versus Plan B-2 and distribution of the velocities across the channel are approximately the same for both plans. The eddy formed in the downstream lock approach is almost identical in size and velocity with Plan C as compared to Plan B-2.

300,000 cfs – Velocities along the left bank immediately upstream of the proposed bridges appear to be higher for Plan C (Figure 13) as compared to Plan B-2 (Figure 14). The velocities are somewhat lower along the right bank for Plan C as compared to Plan B-2 . Velocity distribution across the channel is approximately the same for both plans after passing the downstream end of the Powerhouse Island. Velocities off the end of the Powerhouse Island training dike are lower for Plan C versus Plan B-2. The eddy in the downstream lock approach is approximately the same location, size, and strength for Plan C as compared to Plan B-2.

370,000 cfs – The velocities in the spillway do not indicate any appreciable differences with Plan C (Figure 15) as compared with Plan B-2 (Figure 16). The velocities off the end of the Powerhouse Island training dike are somewhat higher with Plan C versus Plan B-2. The eddy in the downstream lock approach extends slightly less downstream and is slightly higher in velocity with Plan C as compared with Plan B-2.

TOW TRACKS, DOWNBOUND

35,000 cfs – The tracks for Plan C and Plan B-2 (Figures 17 and 18) indicate no change in navigation conditions between the two plans.

79,000 cfs – The tracks for Plan C and Plan B-2 (Figures 19 and 20) indicate no significant differences between the two plans. The ability to turn the tow out into the channel immediately downstream of the Powerhouse Island did appear to be slightly easier for Plan C than for Plan B-2, but neither is difficult.

100,000 cfs – The tracks for Plan C and Plan B-2 (Figures 21 and 22) indicate no appreciable differences between the two plans. In operation of the model tow, the lateral set toward the right descending bankline experienced as the tow comes out toward mid-channel appears to be somewhat less for Plan C than for Plan B-2.

155,000 cfs – The track for Plan C (Figure 23) shows that the tow was not set laterally toward the right descending bankline as much as it was with Plan B-2 (Figure 24). This allows the tow to get out into the channel and aligned to go through the navigation span of the I-24 bridge farther upstream from the bridge as compared to Plan B-2.

300,000 cfs – The track for Plan C (Figure 25) shows that the tow was not set laterally toward the right descending bankline as much as it was with Plan B-2 (Figure 26). This allowed the tow to get out into the channel and aligned to go through the navigation span of the I-24 bridge almost a full tow length farther upstream from the bridge as compared to Plan B-2.

370,000 cfs – The track for Plan C (Figure 27) shows that the tow was not driven as far toward mid-channel as was the track for Plan B-2 (Figure 28). This is due to a noticeable reduction in the lateral set toward the right descending bankline with Plan C that doesn't require the tow to be driven out quite as far toward mid-channel. This allows the tow to come out at a smaller angle to the alignment of the currents and still allows the tow to get into position to go through the navigation span with less maneuvering than was required for Plan B-2.

TOW TRACKS, UPBOUND

35,000 cfs – The tracks for Plan C and Plan B-2 (Figures 29 and 30) show equally successful approaches but different approach strategies. There was no apparent change in a upbound approach due to the Plan C training works.

79,000 cfs – The tracks for Plan C and Plan B-2 (Figures 31 and 32) indicate no apparent differences between the plans. It was noted in the operation of the model tow that the current set toward the right descending bankline was reduced as compared with Plan B-2 and required that the tow be steered toward the right descending bank. This was not a problem but was somewhat different than conditions noted for Plan B-2.

100,000 cfs – The tracks for Plan C and Plan B-2 (Figures 33 and 34) indicate no appreciable differences between the plans. As with the 79,000 cfs flow condition, it was noted that the current set toward the right descending bankline was reduced as compared with Plan B-2 and required that the tow be steered toward the right descending bankline to get the tow on the guide wall. This added no difficulty to the upbound approach.

155,000 cfs – The track for Plan C (Figure 35) shows that the tow was driven slightly further upstream than it was for Plan B-2 (Figure 36) before using the current to push the tow toward the right descending bankline. This was done in anticipation of a possible increase of the current along the west bank of the Powerhouse Island with the Plan C condition. As noted with the 79,000 and 100,000 cfs flow conditions, the strength of this current and the lateral set was somewhat diminished as compared with Plan B-2 and required the tow to be more actively steered toward the right descending bankline than was the case with Plan B-2. This again created no increase of difficulty and the approaches with Plan C were no more difficult than with Plan B-2.

300,000 cfs – The track for Plan C (Figure 37) shows that the tow was steered further toward the left descending bankline and slightly further upstream before using the current to turn the tow toward the right descending bankline than with Plan B-2 (Figure 38) in anticipation of a possible increase of current strength as a result of the Plan C training works. In reality, the current set was somewhat less than that with Plan B-2 and required that the tow be more actively steered toward the right descending bankline. This didn't increase the difficulty of the upbound approach. The approach conditions and difficulty of the approach for Plan C is very similar to that of Plan B-2.

370,000 cfs – The tracks for Plan C and Plan B-2 (Figures 39 and 40) show that the tow was steered slightly farther toward the left descending bank with Plan C before using the current to turn the tow toward the right descending bank. There was a noticeable decrease of the current set with Plan C that required that the tow be more actively steered toward the right descending bankline. This wasn't difficult and didn't increase the difficulty of the approach as compared to Plan B-2.

It can be noted in some of the upbound tracks with Plan C that the tow was steered more toward mid-channel, then turned slightly left to let the current "slide" the tow toward the right descending bank and into the lock approach. According to Charlie Ritchie, this is a typical approach that he performs at similar sites. This approach was used for all the upbound approaches with Plans B-2 and C. It was noted for all of the flow conditions examined with Plan C that the tendency for the tow to be set toward the right descending bankline was lessened as compared with Plan B-2. This allowed the tow to be driven more directly upstream, then using the current (and somewhat more left rudder than with Plan B-2) "slide" across the channel and into the lock approach. The reduction of the tendency for the tow to be set toward the right descending bankline with Plan C requires less corrective steering than with Plan B-2, but the overall approach with either plan is not difficult nor appreciatively different.

CONCLUSIONS

The current directions and velocities indicate that the training structures for Plan C will reduce the size and strength of the large spillway eddy on flows of 100,000 cfs and less. The Plan C structures have a minimal benefit on the spillway eddy at 155,000 cfs and have no apparent affects on the 300,000 and 370,000-cfs flow conditions. There are some changes noted in the size and strength of the eddy that forms in the downstream lock approach, but these changes are relatively small.

The downbound tow tracks indicate that navigation conditions with the Plan C structures in place will be similar to or slightly improved over those with Plan B-2. The upbound tow tracks indicate that navigation conditions will be similar to those of Plan B-2. It was noted that the current set, especially as the upbound tow nears the right descending bankline approximately 1000 ft downstream from the lower end of the guide wall is less than experienced with the Plan B-2 conditions. This reduction of current set with Plan C makes downbound tows somewhat easier to get out into the channel, even though downbound tow passages with Plan B-2 are not difficult. The slight changes to the eddy that forms in the downstream lock approach with Plan C versus Plan B-2 have no appreciable affects on the upbound approaches.

Video taping of dye being injected through the powerhouse and spillway gates with the 100,000 cfs flow condition indicates improved mixing characteristics in the tailrace of the powerhouse with Plan C as compared to the Base Conditions.

Answer to comment 3, 23 Oct 2000

Without knowing which flow condition or which plan that you observed the eddy moving further down the left bank, I can only make some guesses. We looked at several arrangements of training works when the folks for KDFW were here. Some of these arrangements may have lengthened the eddy downstream. The eddies in the model also fluctuate in size over time. I had one pilot describe this in the prototype as "filling and emptying" of the eddy. It is possible that you might have observed the eddy near the peak of one of these "filling" times. Also, we record velocities and current directions with a 9 ft drafted float to get the average velocity and direction of the current that would affect a loaded barge. Observations of the eddies with confetti can show the limits of the eddy at the water surface. It is quite possible that you remember seeing the downstream limits of the eddy as shown by the confetti which would be somewhat farther downstream than the 9 ft draft floats would show it.

Note: The Velocity Vector Figures of the Base, Plan B-2, and Plan C Modeling are to be added at a later date. These figures are included in the DSEIS.

KENTUCKY LOCK ITEM 2
IMPACTS OF NEW LOCK ON TAILWATER MUSSEL BEDS

The Tennessee River from TRM 17.8 to 22.4 (Kentucky Dam) is designated as a mussel sanctuary by the Kentucky Department of Fish and Wildlife Resources because it supports one of the highest concentrations of rare, threatened, and endangered species in Kentucky. The river reach from TRM 12.0 upstream to the dam also is classified as an Outstanding Resource Water in Kentucky due to the assemblage of mussels and gastropods. Relatively dense mussel communities (mussel "beds") occur in suitable cobble and gravel habitats throughout this river reach. Two federal endangered mussel species have been found in this part of the river during recent surveys. It is important that habitat conditions for mussels do not degrade because of flow changes caused by completion of the new lock and associated structures, which include the piers for the new highway and railroad bridges and training dikes for navigation.

Impacts of the new lock and associated structures on the tailwater mussel beds are discussed below. Velocities measured in the model for different project conditions (or plans) and discharges are compared. Depth averaged velocities are estimated at each measurement point and integrated over each cross section to obtain estimates of discharge for comparison with actual discharge. The estimated depth-averaged velocities are also used to estimate prototype shear stresses, whose magnitudes determine the sizes of sediment particles on the bed that may be moved by the flow.

The four project conditions, or plans, referred to below are defined as follows:

- Base plan refers to the existing conditions in the Kentucky Dam tailwater.
- Plan B refers to conditions with the proposed 1200 foot lock, railroad bridge, and highway bridge in place.
- Plan B-2 is plan B with training works installed to improve navigation.
- Plan C is plan B-2 with additional training works installed to reduce the size and strength of an eddy that forms during certain spillway flows.

The measured velocities for two prototype discharges, 79,000 cfs and 300,000 cfs, are used for the mussel impact discussion.

VELOCITY COMPARISONS

Effects of the new lock and associated structures on the tailwater mussel habitat should be measurable as changes in water velocities over the beds. Therefore, velocities at a number of points in the general model were measured using an acoustic doppler velocimeter (ADV) probe for comparison of present, or base, conditions with future conditions. For a number of model discharges and conditions, velocities were measured at 2 feet, 4 feet, 6 feet, and 10 feet (all prototype dimensions) above the bed at 28 points over 5 cross sections in the tailwater. Subsequent examination of these data revealed that the velocities measured 2 feet and 4 feet above the bed were not reliable enough for valid comparison (too much scatter). Presumably, these points were too close to the bed (0.24 and 0.48 inches in the model) for reliable velocity measurements with the ADV probe. The velocities measured 6 feet and 10 feet above the bed were more consistent, but still had variations as large as plus and minus 0.4 ft/sec (plus and minus 10 percent, approximately) when measurements were repeated at a fixed point under equivalent conditions. Because they are the best model data available, the velocities at 6 feet and 10 feet above the bed are compared below to estimate impacts on the mussel beds.

Figures 1 through 5 compare the velocities (scaled to prototype) measured 6 feet and 10 feet above the bed for 79,000 cfs and 300,000 cfs at various measurement points under the four different project plans. Each of the five figures shows all the data for one of the five cross sections. In comparing these data, it is necessary to understand that the base plan data were collected before there was any suspicion about the validity of the data. In hindsight, longer time-averages should have been used for these data and some measurements should have been repeated. The base plan data represent a 30-second time-average of the

measured velocities whereas the data for all other conditions represent a 120-second time-average of the measured velocities. Analysis of typical time traces suggests that the 30-second time-averaged data may differ from the true time-average by as much as 5 percent whereas the 120-second time-averaged data should be within 1 percent of the true time-average. The data collected 6 feet above the bed for cross section 5 with 300,000 cfs (Figure 5) serve as an example of questionable measurements that should have been repeated. The velocities at measurement points 2 and 4 are much lower than appear reasonable. Unfortunately, the base plan data cannot be repeated without significant and expensive model modifications until all tests of the new lock conditions are completed.

Table 1: Differences (In ft/sec) Between Measured Maximum and Minimum Velocities at Each Point

Point	Discharge = 79,000 cfs		Discharge = 300,000 cfs	
	6 feet above bed	10 feet above bed	6 feet above bed	10 feet above bed
X-sect 1				
1			0.2	0.1
2	0.3	0.4	0.5	0.7
3	0.4	0.4	0.4	0.3
4	0.5	0.3	0.4	0.2
5	0.4	0.5	0.3	0.4
X-sect 2				
1	0.2	0.3	0.5	0.5
2	0.5	0.3	0.3	0.3
3	0.6	0.2	0.7	0.2
4	0.7	0.1	0.5	0.1
5	0.6	0.1	0.6	0.1
X-sect 3				
1			0.4	0.3
2	0.4	0.2	0.7	0.3
3	0.7	0.2	1.7	0.4
4	0.9	0.1	0.4	0.5
5	0.5	0.1	0.4	0.2
6	0.7	0	0.6	0.2
X-sect 4				
1			0.7	0.4
2	0.8	0.5	1.0	0.4
3	0.8	0.2	1.7	0.7
4	0.5	0.3	1.2	0.3
5	0.5	0.3	1.7	0.4
6	1.9	0.3	0.7	0.5
X-sect 5				
1			1.1	0.3
2	0.6	0.3	3.4	0.7
3	0.5	0.5	0.9	0.3
4	0.4	0.5	2.1	1.5
5	0.4	0.4	0.7	0.9
6	1.0	0.2	0.4	0.5

Table 1 shows the differences between the maximum and minimum measured velocities at each point for all plans. For example, the velocities measured at point 2, cross section

1 for the 79,000 cfs discharge ranged from a minimum of 3.6 ft/sec for the base plan to a maximum of 3.9 ft/sec for plan B, for a maximum difference of 0.3 ft/sec. Given the observed approximately 10 percent (plus or minus 0.4 ft/sec) variations in the velocity data, it is reasonable to conclude that a difference of 0.3 ft/sec is not significant. In fact, it is difficult to conclude that velocities are actually different at any point where the maximum measured difference is less than about 0.8 ft/sec.

In comparing the data in Figures 1 through 5, it is also useful to consider the relationship between point velocities and total discharge at each cross section. As described below in the section "Integrated Discharges Compared with Supplied Discharges," discharge is equal to the integral of velocity times depth over a cross section. For the data in Figures 1 through 5, the depths at each point did not vary measurably from plan to plan for the same discharge. Therefore, in comparing velocities for two plans, smaller velocities at some points must be balanced by higher velocities at other points if the total cross section discharge is to be the same in both plans.

Figure 1 shows all data for cross section 1. Because this cross section is furthest upstream and closest to the new project features, velocities in this area should be more affected by changed discharge conditions than velocities in the other, more downstream, cross sections. In Figure 1, the velocity data show small differences from plan to plan, but none that are obviously significant or consistent with the requirement that lower velocities at some points are balanced by higher velocities at other points. Furthermore, all the differences in Table 1 for cross section 1 are 0.7 ft/sec or smaller, suggesting that there are no significant differences in velocities for the different plans.

Figure 2 shows all data for cross section 2. As in Figure 1, while velocity differences are present, they are not obviously significant and, in some cases, are not consistent with the requirement of equal discharge. For example, the velocities 6 feet above the bed for the 79,000 cfs discharge are all lower for plan B than for the base plan. For equal discharges, some velocities should be higher and some should be lower. All the differences in Table 1 for cross section 2 are 0.7 ft/sec or smaller, suggesting that there are no significant differences in velocities.

Figure 3 shows all data for cross section 3. Again, it is difficult to find any variations that appear to be other than data scatter. However, Table 1 shows two differences above 0.8 ft/sec in the data taken 6 feet above the bed: 0.9 ft/sec at point 4 for the 79,000 cfs discharge and 1.7 ft/sec at point 3 for the 300,000 cfs discharge. Several arguments suggest that these differences are not realistic. First, it is difficult to understand how velocity differences measured at cross section 3 can be larger than those measured at cross section 1, upstream. Any change in flow pattern due to upstream structures should be evident at cross section 1. Downstream from cross section 1, the flow should gradually become more uniform. Second, the velocity data taken 6 feet above the bed at all points for the 79,000 cfs discharge are higher for the base plan than for any of the other plans, which is not consistent with the requirement of equal discharge. Third, in both cases the differences in the data taken 6 feet above the bed are not present in the data taken 10 feet above the bed at the same location. For example, the velocity 6 feet above the bed at point 3 for the 300,000 cfs discharge is 1.7 ft/sec lower for the base plan than for plan B-2 while the velocity 10 feet above the bed is only 0.4 ft/sec lower.

Figures 4 and 5 show all data for cross sections 4 and 5, respectively. The logic applied above for cross section 3 also applies to these cross sections. Relatively large velocity differences are present, particularly in the measurements taken 6 feet above the bed. At many measurement points, the velocities 6 feet above the bed for the base plan appear to be unreasonably different from those for the other plans. In particular, for the 300,000 cfs discharge the velocities 6 feet above the bed for the base plan are significantly lower than the velocities for the other plans at all measurement points. These differences are inconsistent with the requirement of equal discharge and suggest that the base plan data at these points are unreliable.

In conclusion, examination of the velocity data suggests that the proposed changes associated with the new lock project would not result in significant water velocity changes over the mussel beds below Kentucky Dam. This conclusion is somewhat tentative, however, because of the variability present in the data collected from the physical model.

VELOCITY PROFILES AND SHEAR STRESSES IN AN OPEN CHANNEL

Water flowing over a mussel bed exerts a shear stress on the sediment particles and mussels on the channel bottom. The magnitude of shear stress determines the sizes of sediment particles that may be moved by the flow. Shear stress magnitudes in the prototype can be estimated from depth-averaged velocities determined after fitting standard vertical velocity profiles to the velocities measured 6 feet and 10 feet above the bed in the model. An additional benefit of fitting the velocity data with standard velocity profiles can be realized by integrating the depth-averaged velocities at each cross section to obtain estimates of the model discharge. Comparing these estimates with the actual discharge provides a check on the adequacy of both the velocity data and the fitted velocity profile.

For uniform flow in a wide channel, the following logarithmic "velocity defect" equation is an excellent approximation to measured velocity profiles (e.g., Fischer et al., 1979; Rouse, 1946):

$$\frac{u - u_{max}}{u^*} = 5.75 \log_{10}\left(\frac{z}{d}\right) \tag{1}$$

in which z = vertical distance above the bed, d = depth, u = local velocity (varies with z), u_{max} = maximum velocity (value at surface where $z = d$), and u^* = shear velocity defined as

$$u^* = \sqrt{\frac{\tau_o}{\rho}} = U\sqrt{\frac{f}{8}} \qquad (2)$$

in which τ_o = bed shear stress, ρ = water density, f = Darcy-Weisbach friction factor, and U = depth-averaged velocity. Integration of Equation 1 over the depth leads to the following expression for U:

$$U = u_{max} - 2.5\,u^* \qquad (3)$$

Figure 6 shows dimensionless velocity profiles generated from Equation 1 for two different values of the friction factor, f. Note that in both cases, and for all other values of f, the average velocity, u / U =1, occurs at z / d = 0.3675. Note also, that velocity profiles are steeper in smooth channels (small values of f) than in rough channels (high values of f).

VELOCITY PROFILES IN THE KENTUCKY MODEL

To apply Equation 1 to the Kentucky tailwater, it is necessary to assume that the applicable two-dimensional velocity profile is one where the channel is very wide compared with its depth. This is a reasonable assumption downstream from Kentucky Dam because the tailwater is 1000 feet wide or more at each of the measured cross sections and the depth is less than 50 feet for all tested discharges. It is also necessary to assume that each velocity measurement point is far enough downstream that the dimensionless velocity profile is determined by bottom roughness and not by the disturbed flow around upstream obstructions. This also appears to be a reasonable assumption, with the possible exception of the measurement points in cross section 4, which are just downstream from the piers of the interstate bridge.

In principle, velocity measurements at two values of z are sufficient to determine the unknowns, u_{max} and u^*, in Equation 1. Once these values are calculated, the corresponding friction factor (f) and average velocity (U) can be determined from Equations 2 and 3. The Kentucky model data, however, proved neither consistent enough nor precise enough (only two significant figures) to reliably determine reasonable values of f. Consequently, f was computed based on estimates of bottom roughness in the tailwater. Then two separate values of U were computed using the computed f and the two measured values of $u(z)$. The average of the two U values was taken as the local depth-averaged velocity.

In the model, the roughness height, k_s, was estimated based on data in the literature. Typically (e.g., Rouse, 1946), values of k_s for concrete surfaces are within the range 0.001 feet to 0.01 feet. For “wood floated” or “brushed” surfaces, Miller (1990) specifies a value of 0.25 mm (0.0008 feet) for k_s. For the “brushed cement mortar” surface in the model, k_s is likely to be in the lower end of the concrete range, less than 0.003 feet. After consideration of all available data k_s = 0.002 was selected for use in the velocity profiles.

The resulting friction factors, which vary with Reynolds number and depth in addition to k_s, varied between 0.027 and 0.034 for the 79,000 cfs model discharge and between 0.022 and 0.025 for the 300,000 cfs model discharge.

Figure 7 compares the velocity data collected for the base plan with 79,000 cfs model discharge with a velocity profile based on $f = 0.031$ (a representative value for 79,000 cfs). Figure 8 compares the velocity data collected for plan B-2 with the same velocity profile. All data at both 6 feet and 10 feet above the bed are included in these figures. The variability in the data is evident in both cases, but the assumed velocity profile fits the data better in Figure 7 than in Figure 8. The corresponding plots for plans B and C are more similar to Figure 8 than to Figure 7. A better velocity profile fit to the plan B-2 data can be obtained only by assuming an unrealistic value of approximately 0.15 feet for bottom roughness, k_s (rougher bottom results in less steep velocity profile). It is unclear why the data do not fit a reasonable velocity profile better than indicated in Figure 8.

Figure 9 compares the velocity data collected for the base plan with 300,000 cfs model discharge with a velocity profile based on $f = 0.023$ (a representative value for 300,000 cfs). The corresponding plots for plans B, B-2, and C are similar to Figure 9.

Table 2 lists the depth-averaged velocities determined from the velocity profiles. These values are used below to setimate discharge and to predict prototype shear stresses.

Table 2: Depth Averaged Velocities at Every Measurement Point

Point	Discharge = 79,000 cfs				Discharge = 300,000 cfs			
	Base	B	B-2	C	Base	B	B-2	C
X-sect 1								
1					4.66	4.77	4.77	4.72
2	3.60	3.75	3.70	3.88	5.00	5.42	5.65	5.48
3	4.80	4.49	4.63	4.75	5.14	5.53	5.53	5.36
4	3.24	3.54	3.60	3.65	5.32	5.49	5.54	5.31
5	2.71	3.00	2.85	2.56	5.26	5.41	5.58	5.30
X-sect 2								
1					4.95	5.50	5.27	5.33
2	4.48	4.18	4.08	4.23	5.42	5.69	5.57	5.41
3	4.36	4.16	4.10	4.26	5.56	5.90	5.91	5.84
4	3.65	3.29	3.54	3.30	5.66	5.72	6.00	5.83
5	2.60	2.40	2.54	2.30	4.98	4.81	4.59	4.87
X-sect 3								
1					5.18	5.11	5.11	5.22
2	4.27	4.17	4.08	4.21	5.36	5.81	5.86	5.91
3	4.57	4.37	4.56	4.32	4.71	5.49	5.83	5.71
4	4.30	3.90	3.80	3.90	5.61	6.10	6.05	6.04
5	3.55	3.50	3.30	3.40	5.26	5.25	5.43	5.54
6	2.57	2.37	2.22	2.37	4.85	4.63	4.63	4.40
X-sect 4								
1					4.76	5.13	5.35	5.24
2	3.65	3.98	4.13	4.02	5.20	5.64	5.97	5.59
3	4.81	4.71	4.57	4.46	4.68	5.90	5.90	6.01
4	4.31	4.46	4.27	4.66	5.25	5.99	6.04	6.09
5	4.45	4.12	4.17	4.46	4.26	5.43	5.32	5.21
6	3.91	2.93	2.95	3.09	4.37	4.75	4.44	4.92
X-sect 5								
1					4.61	5.27	5.04	5.38
2	4.22	4.14	3.89	4.28	3.69	5.70	5.92	5.97
3	4.20	4.38	4.14	4.28	5.19	5.64	5.65	5.86
4	4.34	3.95	3.95	4.25	4.43	5.57	5.63	4.98
5	3.79	3.70	3.45	3.75	4.49	4.89	5.00	4.47
6	3.16	2.82	2.72	2.63	3.74	3.83	3.90	3.62

INTEGRATED DISCHARGES COMPARED WITH SUPPLIED DISCHARGES

In principle, discharge determined by integrating depth-averaged velocities in the tailwater at any cross section should equal the discharge passing through the dam. In reality, the number of velocity measurement points at each cross section in the Kentucky general model were insufficient to produce an accurate calculation of the discharge. Nevertheless, as a check on the reasonableness of the velocity data, discharges obtained by integrating depth-averaged velocities are compared below with the measured discharges supplied to the model.

The depth-averaged velocities were integrated as follows to obtain discharge estimates for each cross section:

$$Q = \int_0^w U(x)d(x)dx \approx \sum_{i=0}^{n-1} \frac{1}{2}\left(U_{i+1}d_{i+1} + U_i d_i\right)\left(x_{i+1} - x_i\right) \qquad (4)$$

in which Q = discharge, w = channel width, x = distance coordinate across channel ($x_o = 0$, $x_n = w$), $U_i d_i$ = discharge per unit width of channel at the i^{th} measurement point ($U_o d_o = U_n d_n = 0$), and n = number of measured U and d values.

The discharges calculated using the model data in Equation 4 are presented in Table 3.

Table 3: Discharges (in cfs) Determined by Integrating Depth-Averaged Velocities

	Supplied Discharge = 79,000 cfs				Supplied Discharge = 300,000 cfs			
X-sect	Base	B	B-2	C	Base	B	B-2	C
1	75,900	78,000	78,100	78,800	274,900	288,800	293,800	283,500
2	72,600	67,700	68,100	68,300	285,700	296,800	293,700	293,200
3	71,000	67,500	66,300	67,100	285,200	299,800	304,800	304,100
4	74,100	72,100	71,800	73,700	264,200	305,700	307,100	307,500
5	77,000	74,500	71,200	75,700	246,400	292,000	295,100	285,000

For the 79,000 cfs model discharge, all integrated discharges are low, ranging from 66,300 cfs (16 percent low) to 78,800 cfs (0.3 percent low). The reason they are all low is unclear, but the trapezoidal integration procedure expressed by Equation 4 may underestimate the portions of total discharge between the riverbanks and the measurement points closest to the banks. Equation 4 assumes a linear decrease in Ud from U_1d_1 to zero between x_1 and x_o and from $U_{n-1}d_{n-1}$ to zero between x_{n-1} and x_n. In reality, the decreases in both velocity and depth between these measurement points and the adjacent riverbanks are probably more parabolic than linear. For the 300,000 cfs model discharge, most of the integrated discharges are low but a few are high, with values ranging from 246,400 cfs (18 percent low) to 307,500 cfs (2.5 percent high). In general, the integrated discharge values are close enough to the supplied discharge values to conclude that the measured velocities are at least reasonable.

This comparison suggests that the depth-averaged velocities determined from the fitted velocity profiles are lower than they should be; however, this conclusion is uncertain because the small number of measurement points limits the accuracy of the discharge estimates. If the depth-averaged velocities are low, it may be because the velocities measured 6 feet above the bed are too low. This speculation is suggested by comparing the velocities measured 4 feet and 2 feet above the bed with values predicted from the fitted velocity profiles. All of these velocities appear to be too low with the difference between the measured and expected values decreasing with increasing distance from the bed. It may be that the velocities measured 6 feet above the bed also are low, but not so much as to appear unreasonable. If these velocities were higher, then the integrated discharges would be larger and the velocity profiles illustrated in Figures 8 and 9 would fit the data better.

PROTOTYPE SEDIMENT MOVEMENT

The shear stress associated with water flowing over a mussel bed is capable of moving sediment particles that are smaller than a critical size determined by the magnitude of the shear stress. As expressed by Equation 2, shear stress across the bed is proportional to the friction factor (which depends on bottom roughness) and to the square of the depth-averaged water velocity. If water velocity increases over a mussel bed, the increased shear stress can remove previously stable sediment particles from the bed or can transport previously stable material from upstream to the bed. Because mussels normally reside within the stable layer of sediment at the channel bottom, increased shear stresses that disturb this layer could disturb the mussels. On the other hand, if water velocity decreases over a mussel bed, relatively fine suspended sediment particles from upstream can settle out over the bed, changing its particle size distribution. This effect could be detrimental to mussels preferring the existing coarse gravel and cobble bottom. However, the water flowing below Kentucky Dam is unlikely to carry much suspended sediment. Channels below dams tend to become “armored” or “paved” because upstream sediment supplies are cut off by the dam. Finer particles in the bottom sediment are gradually removed and are not replaced. The coarser particles remain on top of the bed. In the Kentucky Dam tailwater, these coarser particles are cobble and gravel.

Shear stresses in the prototype can be estimated using the depth-averaged velocities from model data along with an estimate of bottom roughness. The estimated shear stresses can then be used to predict the sizes of particles moved by the flow.

The prototype roughness height, k_s, depends on the sizes of sediment particles covering the channel bottom. There is no universally applicable relationship between roughness height and sediment size in an alluvial channel but the effective value of k_s is typically greater than the median sediment diameter, d_{50}. Investigators have assumed values for k_s ranging from d_{65} (the subscript indicates the percentage of particles smaller than the indicated diameter) to $2d_{65}$ (ASCE, 1975).

Table 4: Percent Gravel, Sand, and Fines in Sediment Samples from Mussel Sites below Kentucky Dam

Site	Percent by Weight		
	Gravel (dia > 5 mm)	Sand (dia = 0.075 to 5 mm)	Fines (dia < 0.075 mm)
1	61.5	37.6	0.8
2	66.1	32.7	1.1
3	64.8	34.1	1.1
4	83.3	15.9	0.8
5	82.8	17.0	0.2
6	60.4	38.9	0.7

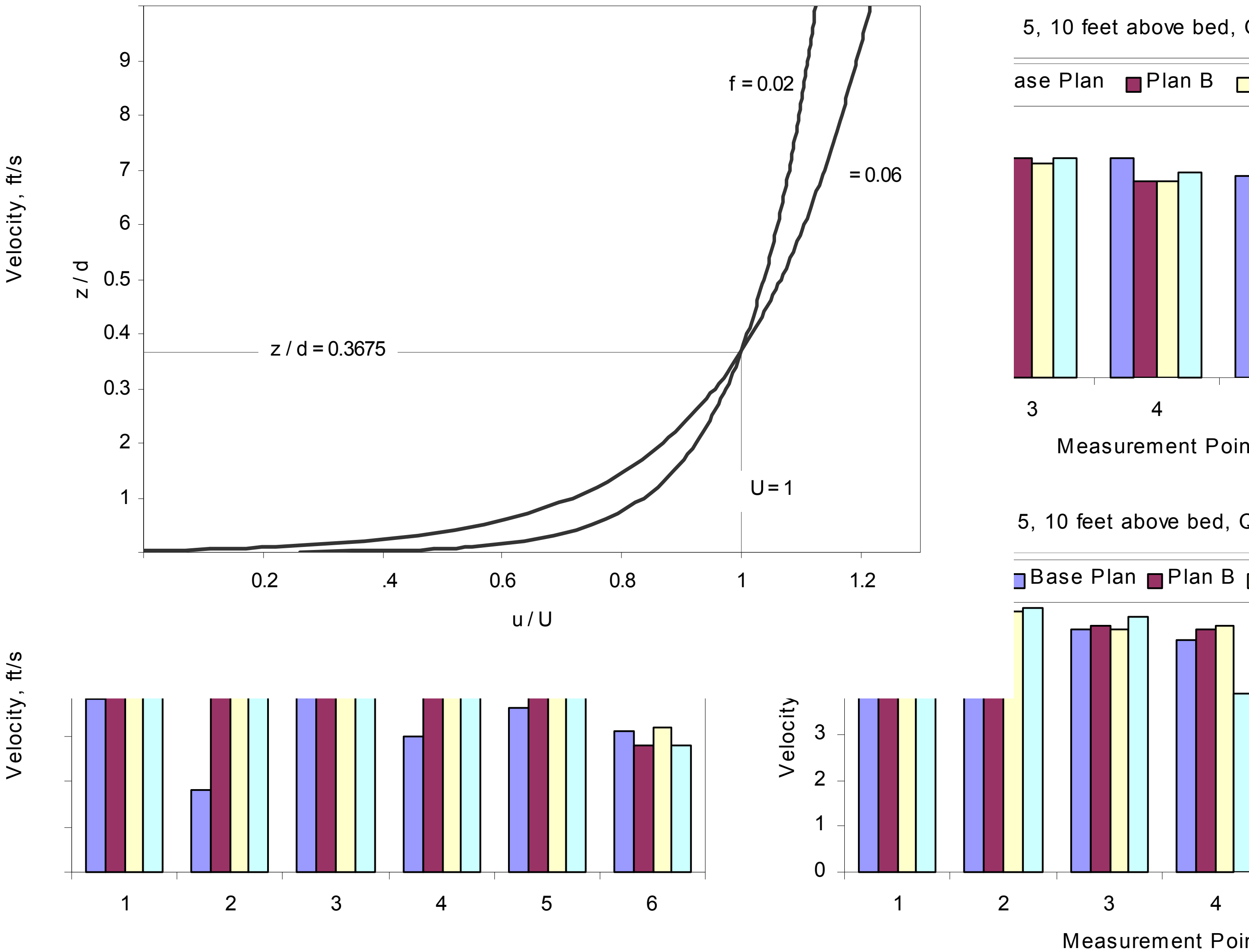
Table 4 summarizes particle size data provided by Miller and Payne (1991) from six sites in the Kentucky Dam tailwater. At the sampled sites, the bottom sediment consisted mainly of gravel (defined by Miller and Payne as particles with diameters greater than 5 mm), with lesser amounts of sand and fines. Unfortunately, the data are insufficient to estimate d_{50} or d_{65} for the bottom sediment. With over 60 percent of the sediment described as gravel, both d_{50} and d_{65} are greater than 5 mm, possibly much larger than 5 mm. In sedimentation engineering, gravel is defined as sediment particles ranging in size from 2 to 64 mm and cobble is defined as sediment particles ranging in size from 64 to 256 mm. Consequently, particles larger than 5 mm found in a "cobble and gravel" bottom could conceivably range in size from 5 mm to 256 mm.

In the following calculations of shear stresses needed to predict critical sediment sizes, the value of k_s is assumed to be 25 mm. This value results in friction factors varying from about 0.017 to 0.020 for tailwater discharges of 79,000 and 300,000 cfs. Fortunately, the friction factor is relatively insensitive to the value of k_s. For example, if k_s = 5 mm, f would vary from about 0.012 to 0.014, while if k_s = 50 mm, f would vary from about 0.020 to 0.024.

The Shields diagram (ASCE, 1975) relating dimensionless critical shear stress to boundary Reynolds number can be used to estimate the sediment sizes transported by flows in the Kentucky tailwater. Table 2 includes depth-averaged velocities varying from 2.2 ft/sec to 4.8 ft/sec for the 79,000 cfs discharge. The Shields diagram indicates that the lower velocity is capable of moving particles smaller than about 1.7 mm in diameter and the larger velocity is capable of moving particles smaller than about 5.7 mm in diameter. For the 300,000 cfs, Table 2 includes depth-averaged velocities varying from 3.6 ft/sec to 6.1 ft/sec. The Shields diagram indicates that the higher velocity is capable of moving particles smaller than about 7.5 mm in diameter. These results are consistent with the data showing that the tailwater bed is covered primarily by gravel and cobble particles larger than 5mm in diameter. These results also suggest that a change in velocity on the order of 1 ft/sec would change the size distribution of the bottom sediments slightly, but the bottom surface would still consist primarily of gravel and cobble. Therefore, a change in velocity on the order of 1 ft/sec is unlikely to significantly impact the mussel beds.

CONCLUSIONS

Comparison of velocity data collected for future conditions (plan B, plan B-2, and plan C) with velocity data collected for present conditions (base plan) suggests that no significant changes in velocities over the mussel beds below Kentucky Dam are likely to occur with the new lock in place. This conclusion is tenuous because of the variability in the data. When considering velocity data, it is important to remember that even under present conditions the mussel beds experience a range of velocities, suggesting that changes of a few tenths of a foot per second are unlikely to be significant. Velocity at a given point in the tailwater depends on the amount of the discharge from the dam and the



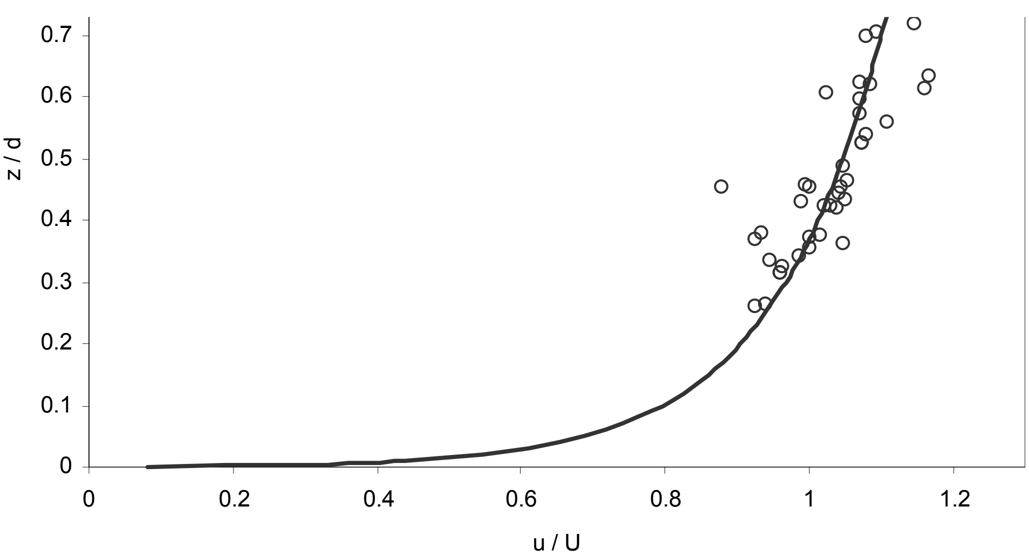


Figure 7: Velocity data compared with velocity profile, Q = 79,000 cfs, base plan.

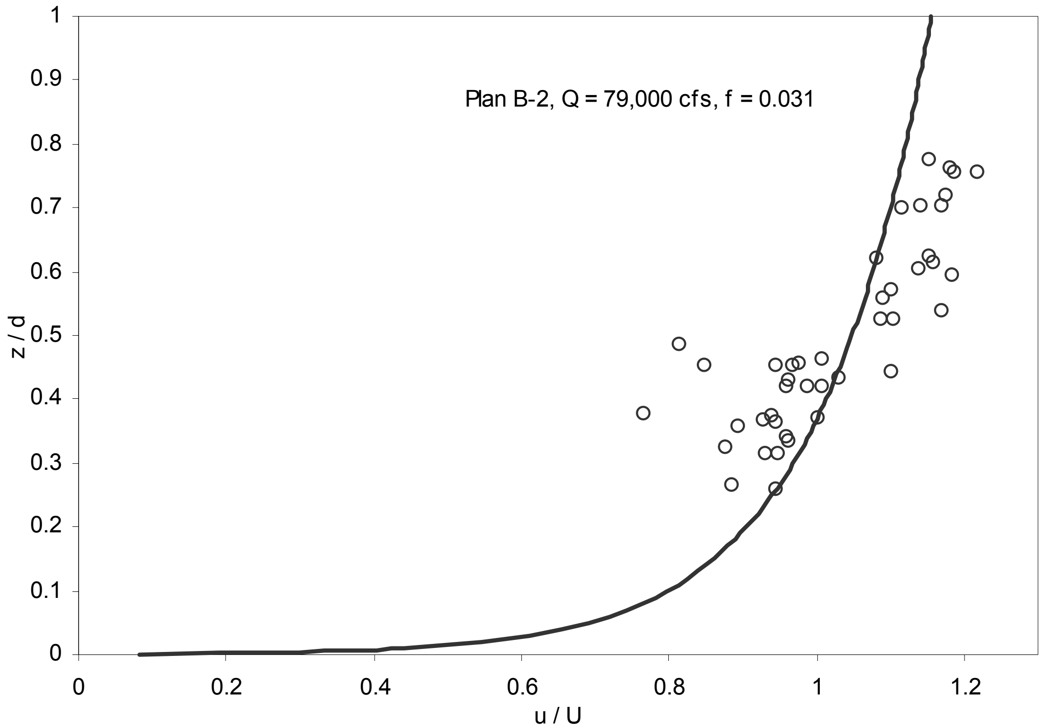


Figure 8: Velocity data compared with velocity profile, Q = 79,000 cfs, plan B-2.

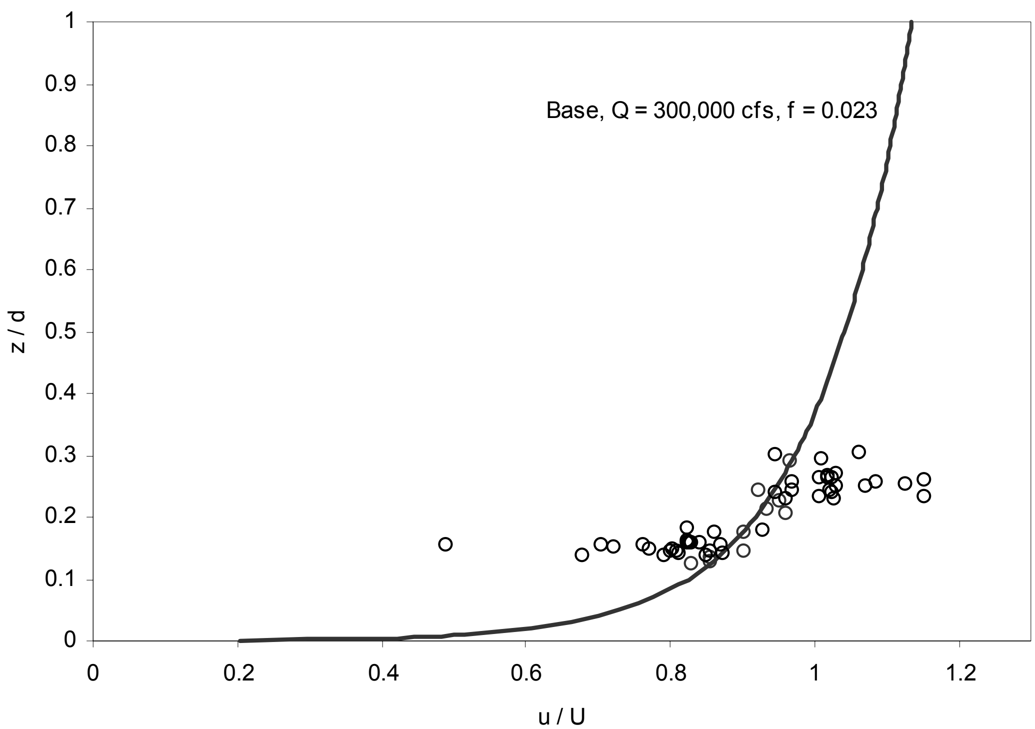


Figure 9: Velocity data compared with velocity profile, Q = 300,000 cfs, base plan.

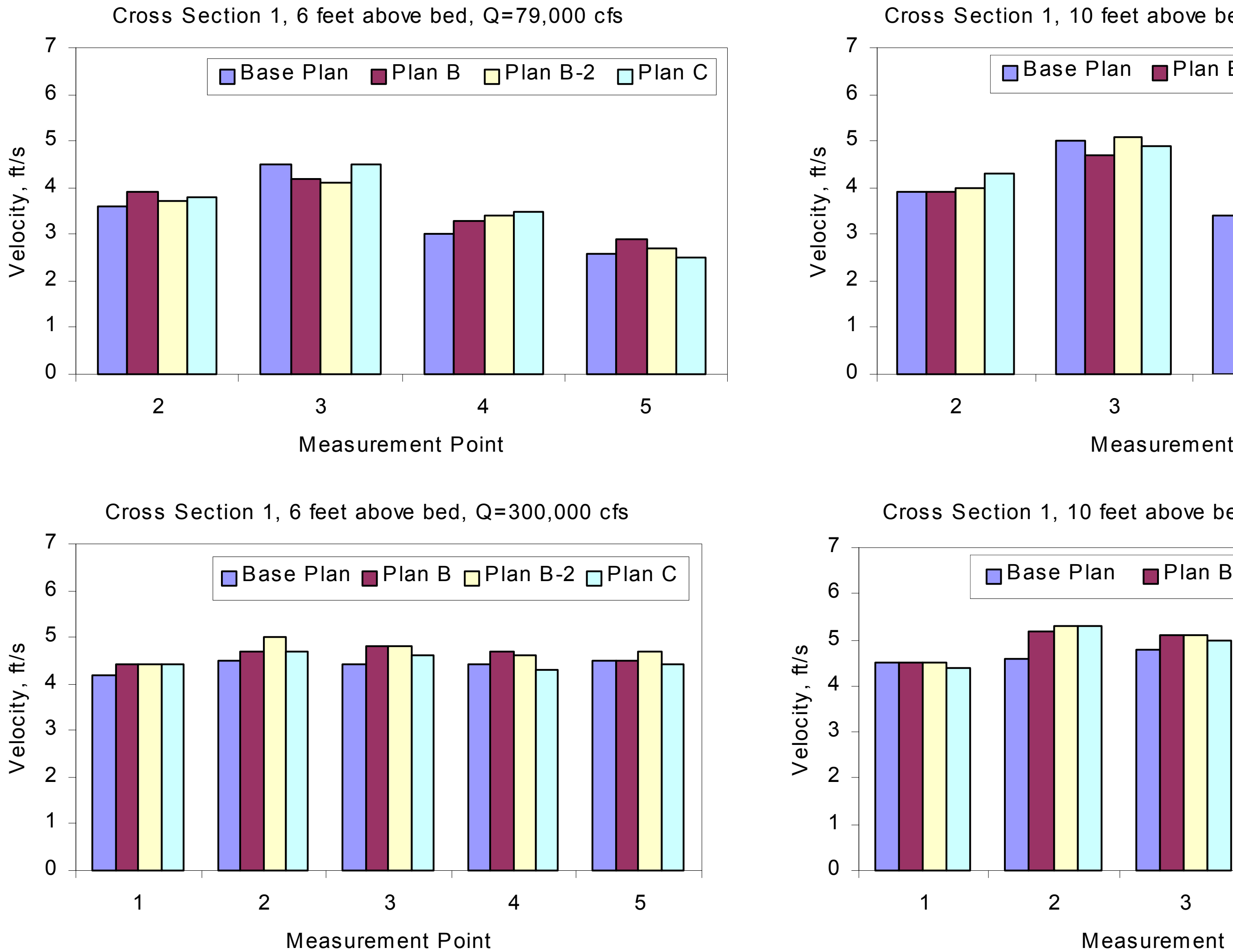


Figure 6: Velocity Comparisons at Cross Section 1

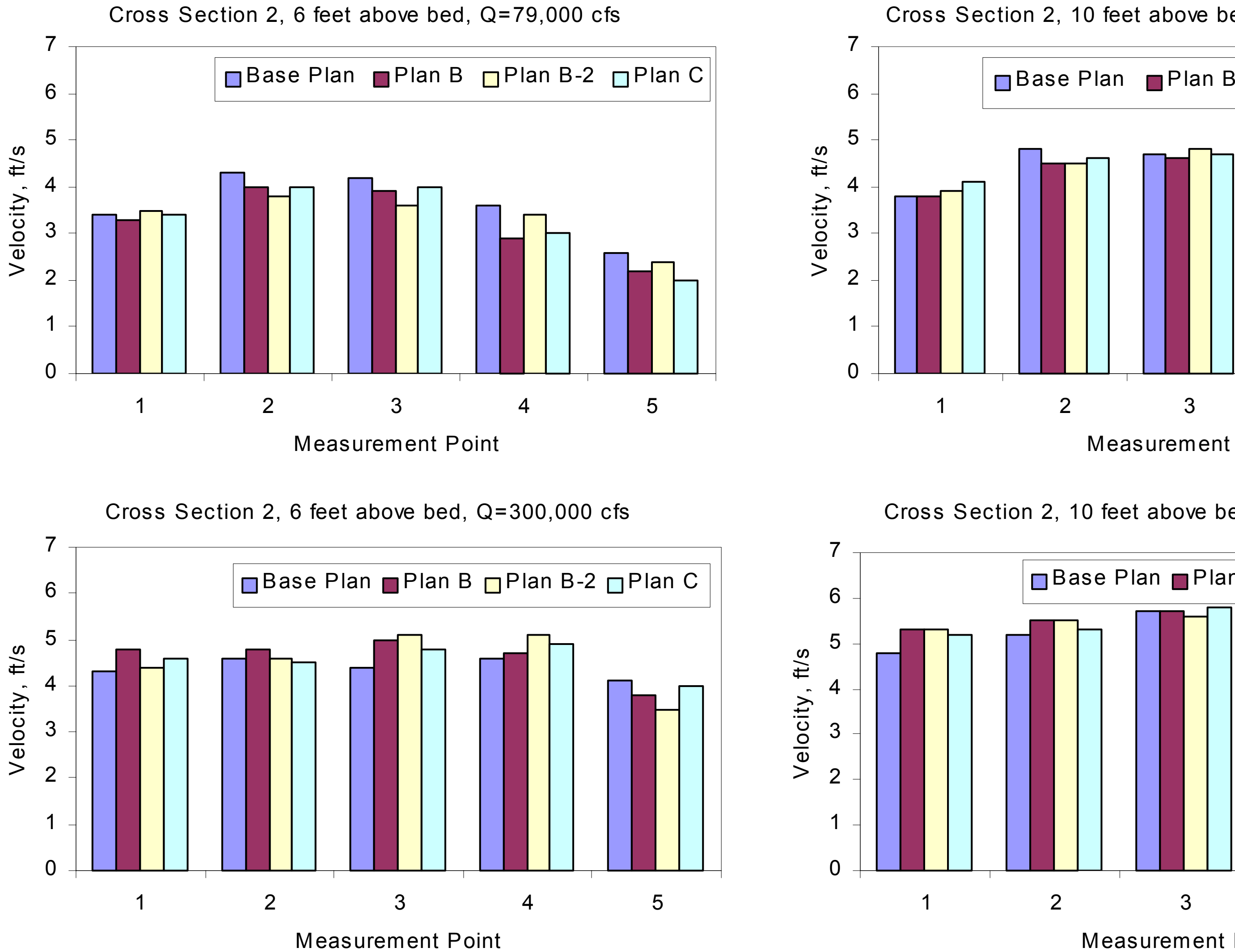


Figure 7: Velocity Comparisons at Cross Section 2

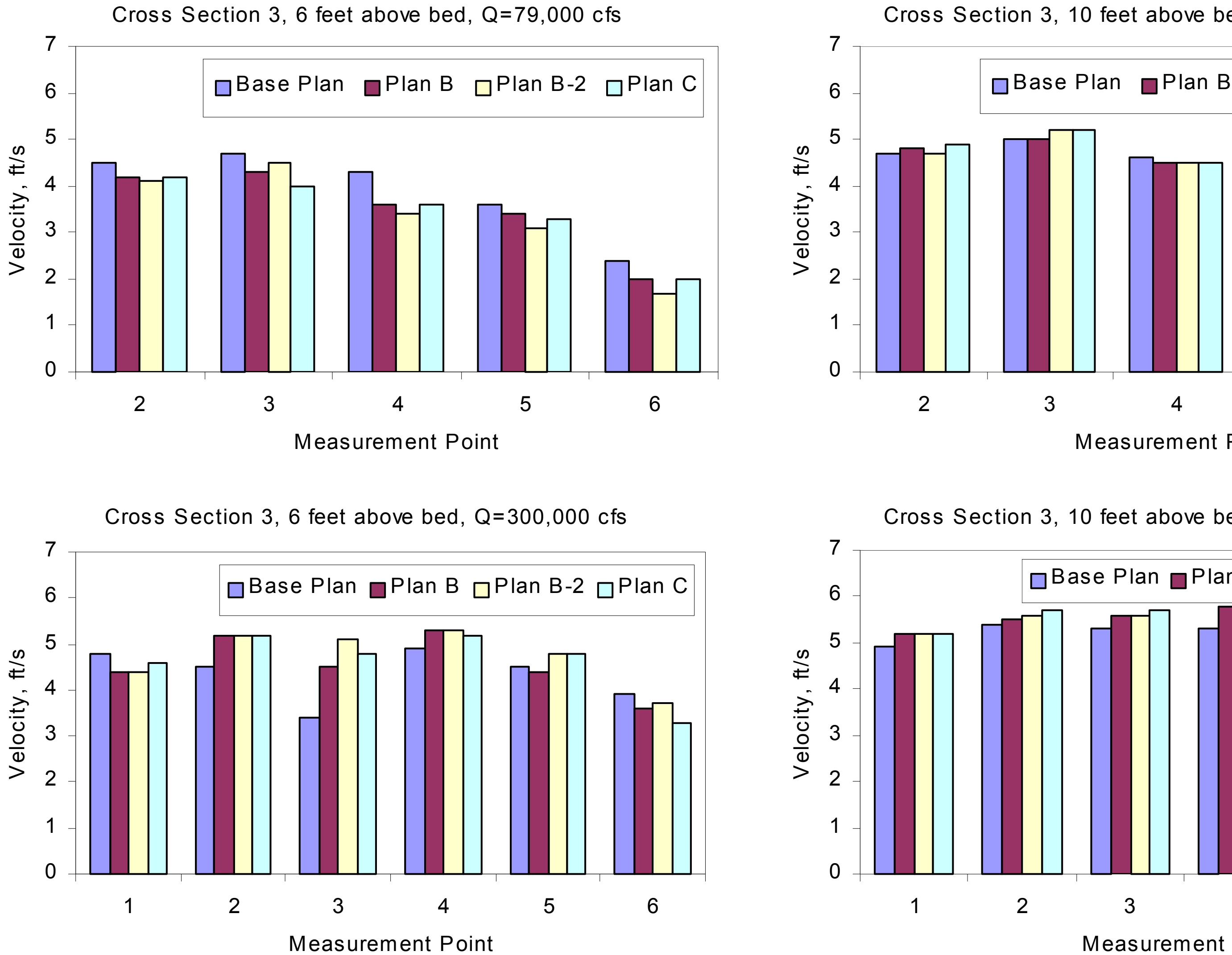


Figure 8: Velocity Comparisons at Cross Section 3

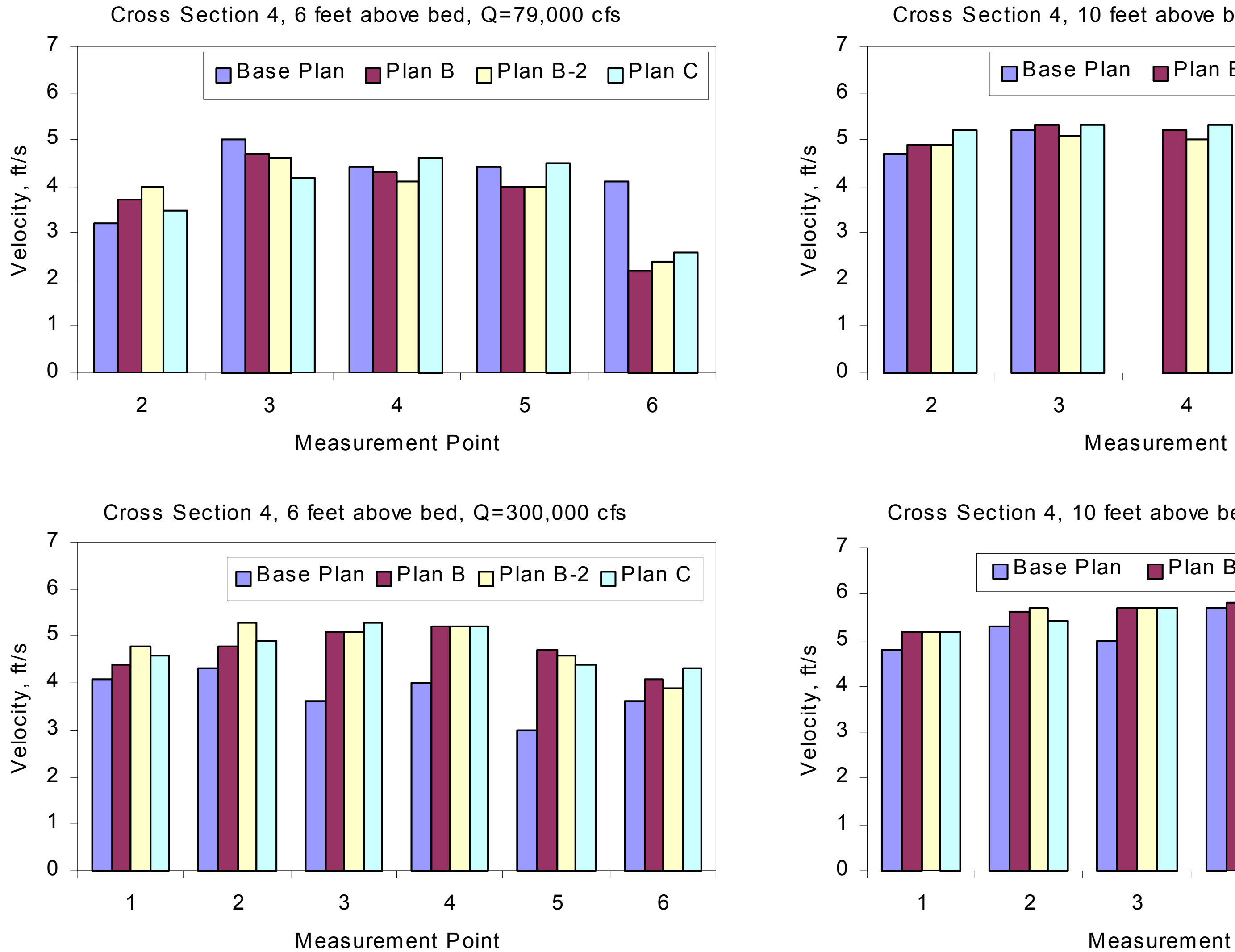


Figure 9: Velocity Comparisons at Cross Section 4

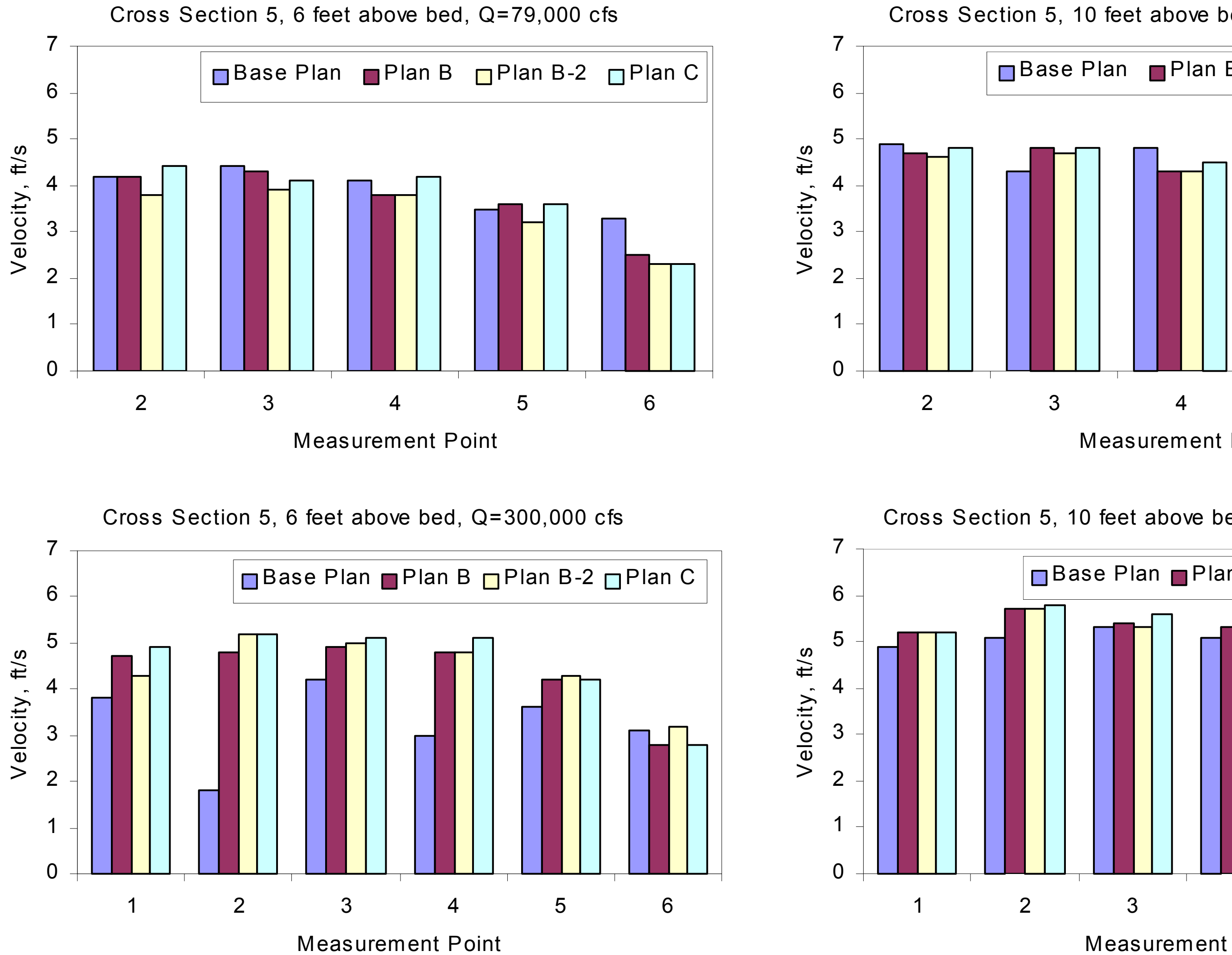


Figure 10: Velocity Comparisons at Cross Section 5

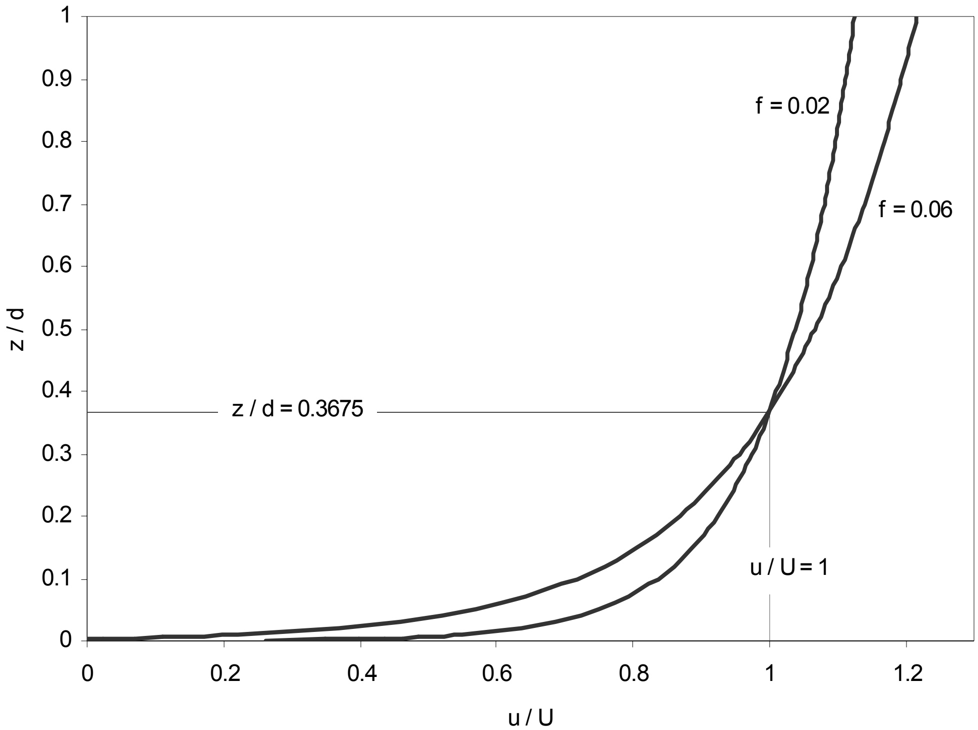


Figure 6: Sample velocity profiles

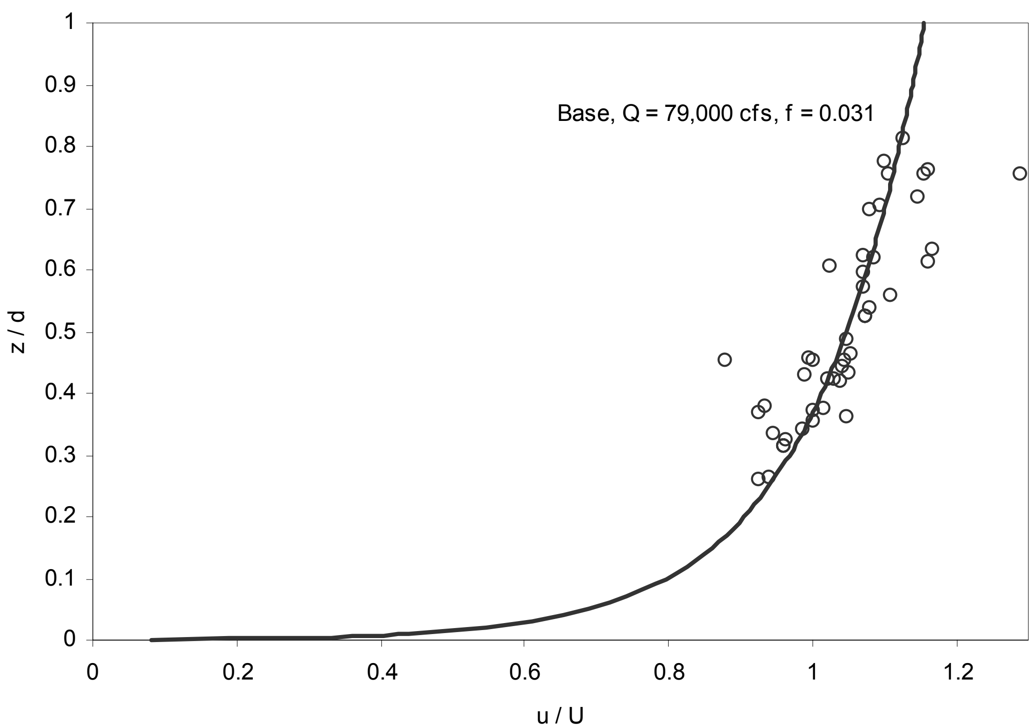


Figure 7: Velocity data compared with velocity profile, Q = 79,000 cfs, base plan.

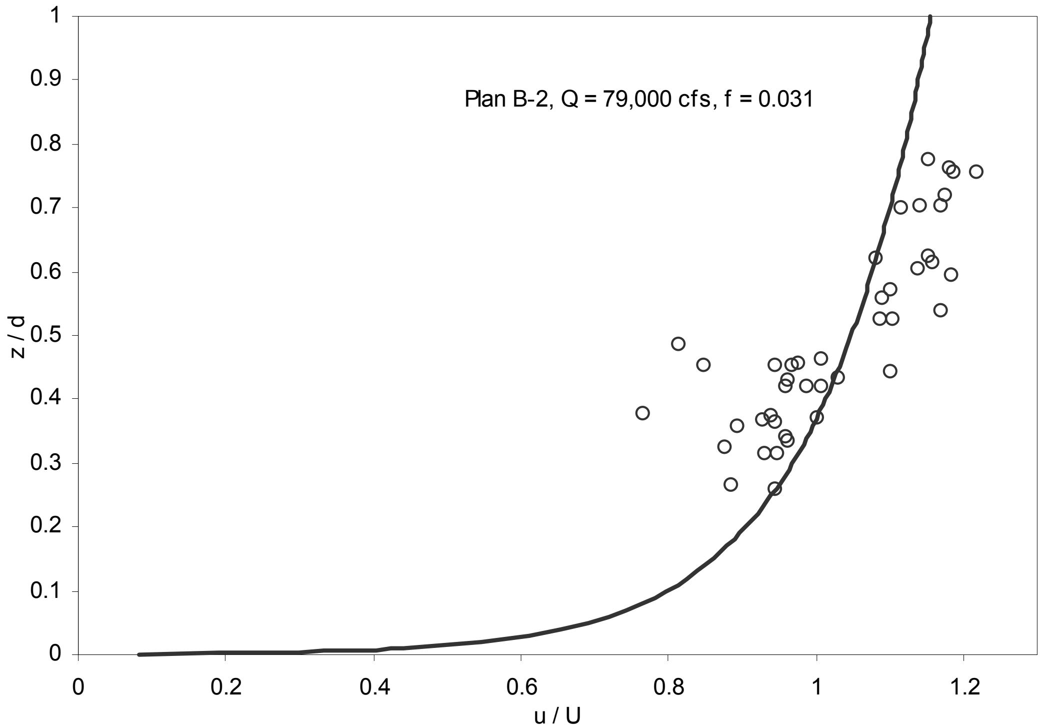


Figure 8: Velocity data compared with velocity profile, Q = 79,000 cfs, plan B-2.

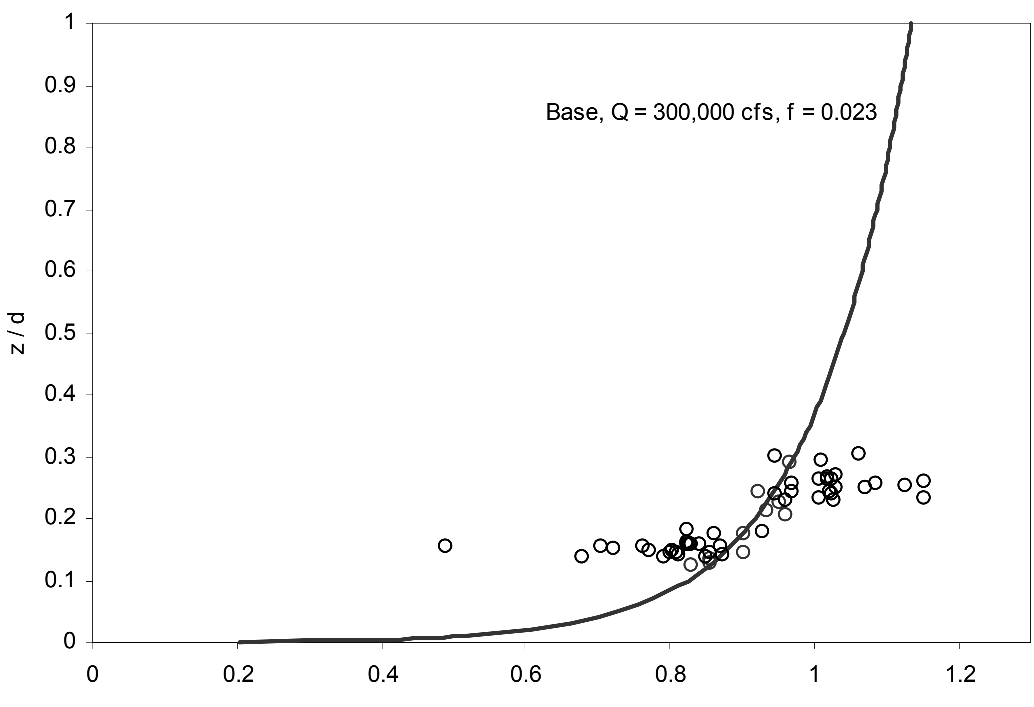


Figure 9: Velocity data compared with velocity profile, Q = 300,000 cfs, base plan.

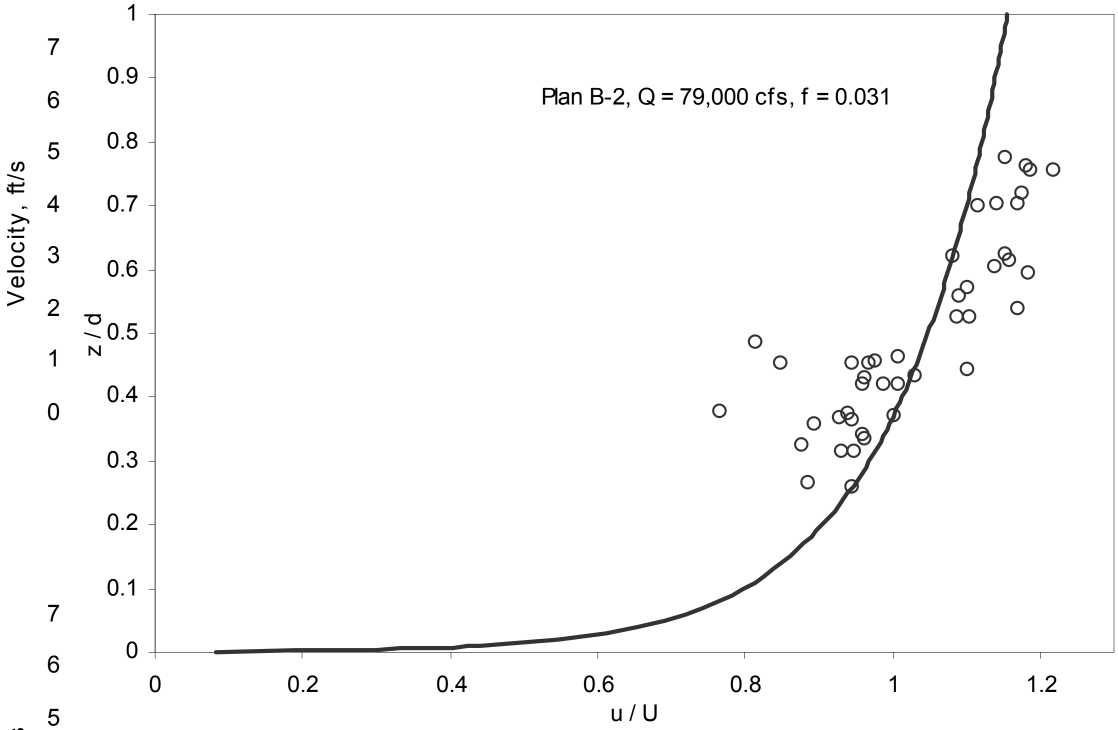


Figure 8: Velocity data compared with velocity profile, Q = 79,000 cfs, plan B-2.

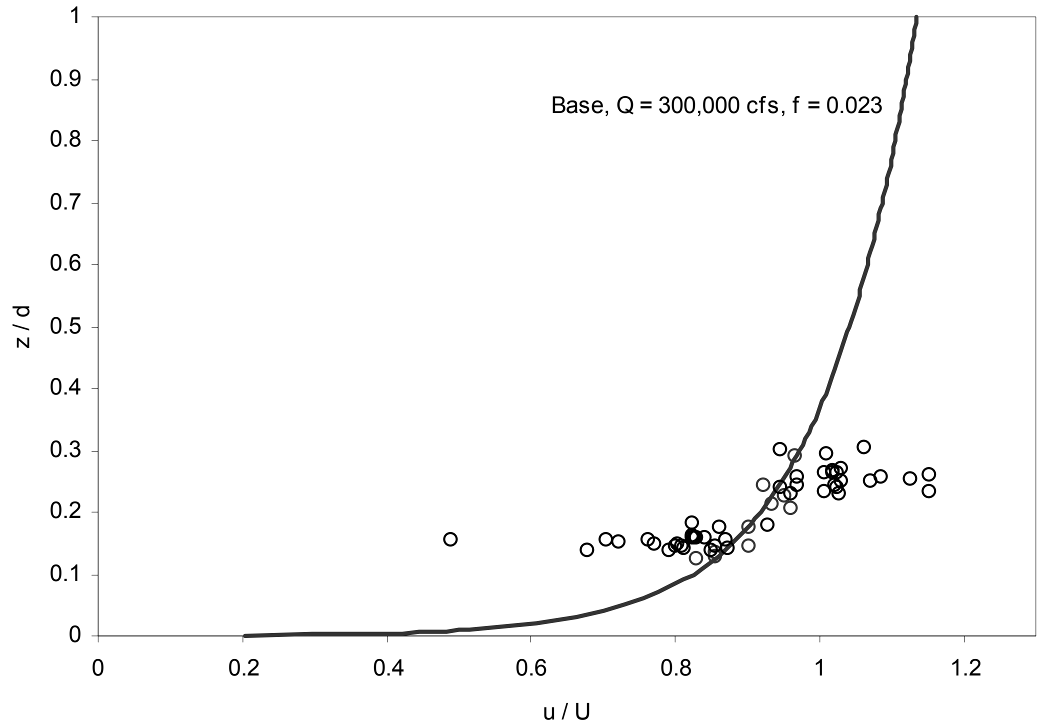
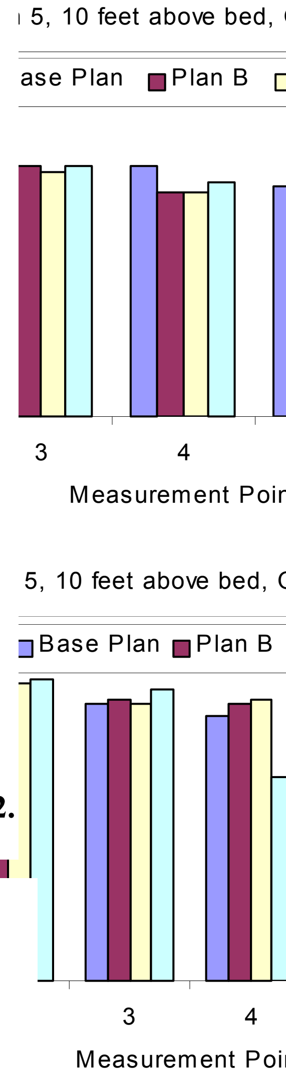


Figure 9: Velocity data compared with velocity profile, Q = 300,000 cfs, base plan.



Item 3

DRAFT SECTION 404(b)(1) EVALUATION
Kentucky Lock Addition Project
Draft Supplemental Environmental Impact Statement

I. PROJECT DESCRIPTION

a. LOCATION: The location of the Kentucky Lock Addition Project is at Kentucky Lock and Dam (L&D) project on Tennessee River Mile 22.1 in Marshall and Livingston Counties, Kentucky. The Nashville District, Corps of Engineers (Corps), is now completing a Draft Supplemental Environmental Impact Statement (DSEIS) for known changes to the project that were not covered by previous NEPA documents. Previous changes associated with the relocation of the U.S. Highway 62/641 bridge were covered by the March 2000 Highway Relocation Environmental Assessment. This included fill placement in 7 acres of wetlands from the relocated highway and railroad embankments.

b. GENERAL DESCRIPTION: The purpose of this 404(b)(1) evaluation is to address actions that involve discharges of dredged or fill material into waters of the U.S. Fill activities above the level of Ordinary High Water (OHW) are not subject to this evaluation.

Alternatives with potential application to the Lock Addition Project are documented in the original Feasibility Study and the Environmental Impact Statement completed in 1992 and the U.S. Highway 62/641Relocation Environmental Assessment (EA), USACE March 2000. Alternatives evaluated in this DSEIS included No Action (reverting back to previously approved plans from either the 1992 FEIS or 2000 Highway Relocation EA) and the Proposed Action (implementing design changes covered in the DSEIS).

For the purposes of this Section 404(b)(1) evaluation, the project activities subject to Section 404 requirements include placement of fill material in the Tennessee River for several features as listed in Table 1.

c. AUTHORITY AND PURPOSE

Construction of a new lock at Kentucky Dam was authorized by the Water Resources Development Act (WRDA) of 1996. The Corps published a Notice of Intent (NOI) in the Federal Register on May 12, 2000 announcing the intent to perform a DSEIS for the project. The NOI listed the known project features that would be evaluated and stated that several features would require a 404(b)(1) guidelines evaluation. The primary purpose of the lock addition project is to reduce the river navigation backlog at Kentucky L&D. The purpose of the various features covered in the DSEIS include mitigation for recreational impacts and addressing river navigation conditions (refer to Table 1).

d. GENERAL CHARACTERISTICS OF FILL MATERIAL

(1) General Characteristics of Material. Fill material would be clean rock fill or riprap suitable for bank stabilization, dike, jetty or lock wall construction.

(2) Quantity of material. The total quantity of fill material to covered in this evaluation is approximately 115,000 cubic yards (CY). Amounts for individual features are listed in Table 1 (at end of evaluation). Note that 82% of the total fill volume is for construction of the spillway training dikes.

(3) Source of Material. The fill material would be clean rock obtained from excavations elsewhere in the lock construction or from commercial sources.

e. DESCRIPTION OF PROPOSED DISCHARGE SITE

(1) Location: Figure 2 of the DSEIS shows the general location of each feature covered in this evaluation. All the features would be located in either the Kentucky Dam tailwaters or in Kentucky Lake immediately above the dam.

(2) Size, (3) Type of Site, and (4) Type of Habitat: The area covered by the various features is listed in Table 1. The largest feature is the spillway training dikes, which cover about 3.2 acres. The navigation training dike covers about 0.2 acres and the fishing jetties about 0.5 acres. The other features require minor area and are located in the immediate vicinity of the new lock chamber and lock approach walls. Most of these areas to be filled are within areas to be of excavated (with the exception of the slurry wall). The type of site is riverine for the tailwater features with generally scoured substrate of gravel and cobble due to the high velocities in the tailwater. The headwater features are in lacustrine areas. The Access road to the riverward lockwall would be over previously riprapped banks on the face of the dam.

(5) Timing and Duration of Discharge: Construction of the proposed features begins in summer 2001. With the exception of the slurry wall and coffercells, the construction activities would be of a permanent duration. The slurry wall and coffercells would be of temporary nature during construction of the lock. The lock completion is estimated to be around 2007-2010 depending on future funding levels.

f. DESCRIPTION OF DISPOSAL METHOD

Materials would be placed by a method to be determined by the contractor. Typically, rock would be stored on barges or on the adjacent shore and placed by cranes at the work site.

II. FACTUAL DETERMINATIONS

a. PHYSICAL SUBSTRATE DETERMINATION

(1) **Substrate Elevation and Slope:** The final elevation and slope would be as shown on the figures in the DSEIS for each structure.

(2) Sediment Type: Clean rock would be used of a size to withstand expected velocities.

(3) Dredged/Fill Material Movement: Fill material would be sized to withstand the high velocities that can occur in the tailwater. The intent is to provide a stable structure that would have minimal displacement over time.

(4) Physical Effects on Benthic Macroinvertebrates: Construction of the proposed features would have permanent (burial) impacts on benthic macroinvertebrates in the footprint of each feature. Minor siltation would occur downstream of the site during construction. Recolonization by benthic macroinvertrebrates should occur over time with improved substrate and reduced velocities behind the two training dikes and west bank jetties.

(5) Actions That Would Be Taken to Minimize Adverse Impacts

- In order to protect fish spawning areas, seasonal restrictions on in-stream activity would be followed per the 401 water quality certification.

- Mussel relocation is proposed from the footprint of the west bank fishing jetties and within the navigation channel. Relocation from other features would be considered where feasible, with diver safety being a limitation.

b. WATER CIRCULATION, FLUCTUATION, AND SALINITY DETERMINATIONS

(1) Water

(a) Salinity: Not applicable.

(b) Water chemistry: No significant effects.

(c) Clarity: The proposed action would cause minor periodic short-term increases in total suspended solids (TSS) in areas downstream of the filled areas during and immediately after construction. The use of clean rock should minimize this effect. Once construction is complete there should not be any significant long-term changes from current conditions.

(d-i) Color, Odor, Taste, Dissolved gas levels, Eutrophication, & Nutrients: No significant effects. Minor positive effects on dissolved gas levels are anticipated from the spillway training dikes.

(2) Current Patterns and Circulation

(a) Current patterns and flow: During the design of the structures, a physical model was utilized to evaluate the effects of the various features on river currents. The navigation training dike does reduce the eddy strength that forms below the tip of the powerhouse island, thereby, improving commercial navigation for upbound traffic. The spillway training dikes reduce the size and strength of the west bank eddy that forms near the dam, thereby, improving recreational boating safety. The other features have minimal effect on patterns and flow. The current alterations made by the two sets of dikes would not be of the magnitude to affect biological communities in the tailwaters, although some fisherman use patterns may change on the west bank.

(b) Velocity: As discussed above, velocities in the two eddies are reduced to the point where river navigation and safety is improved. Detailed analysis is provided in Appendix B in the WES modeling (Item 1) and TVA Hydraulic Evaluation Reports (Item 2).

(c) Stratification: No significant effects.

(d) Hydrologic regime: No significant effects.

(3) Normal Water Level Fluctuations: The proposed action would produce insignificant rises in tailwater levels. Under high flow conditions, the maximum effects would be a rise of 0.3 feet or less. The effected area would be the immediate tailwater area, primarily TVA and State Park lands. This is discussed in the DSEIS under the floodplain analysis section (Sections 4.5 and 5.5).

(4) Salinity Gradients Not applicable.

(5) Actions That Would Be Taken to Minimize Adverse Impacts: Same as item II.a. (5).

c. SUSPENDED PARTICULATES/TURBIDITY DETERMINATIONS

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site

Placement of clean rock fill material for the various structures covered in this DSEIS would result in short-term suspension of particulates (soil and sediment) that would slightly increase turbidity and TSS. However, adverse impacts would be limited to periods of construction. Shortly after the activities cease, suspended particulates and turbidity in downstream waters should return to normal levels. The increases in TSS and turbidity would be similar to the typical variation seen in the tailwater in response to runoff events.

(2) Effects on Chemical and Physical Properties of the Water Column

Temporary increases in suspended sediment load and turbidity would interfere with light penetration in downstream areas. However, adverse impacts would be limited to periods of active construction and a short period following the activity. Once this activity ceased, particulate and turbidity levels should return to normal levels. The placement of clean fill material would not have a significant effect on toxicity. The proposed action should not have any significant effects on pathogens.

(3) Effects on Biota

(a-c) Primary production/photosynthesis, Suspension/filter feeders, & Sight feeders: There would be slight short-term decreases in primary production and photosynthesis during construction because of increases in TSS and turbidity in the immediate area downstream of the construction site. The use of clean rock fill would minimize this effect. There could be some mortality of suspension or filter feeders and sight feeders during periods of construction because of placement of fill material and downstream increases in TSS levels. Long-term effects would not be significant.

(4) Actions that would be taken to minimize adverse impacts: Refer to Section II a. (5).

d. CONTAMINANT DETERMINATIONS: It is unlikely that the project would significantly effect any levels of contamination. The proposed fill material should be clean and free of contaminants. The existing river substrate does not have any known contaminant problems, limited sediment sampling has been performed by the Corps. The Corps performed a Phase 1 Environmental Site Assessment on areas required for the project.

e. AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

(1) Effects on Plankton, Benthic Macroinvertebrates, Nekton: The proposed action would cause some minor mortality because of increases in TSS and turbidity and decreases in DO levels during construction periods. Periods of impacts would be temporary and of relatively short duration. Long term effects would be positive for benthic macroinvertebrates with improved habitat from the rock structures. The proposed action would not have any significant effects on plankton and nekton.

(2) Effects on Aquatic Food Web: The proposed action should have minor negative short-term and minor positive long-term effects on the aquatic food chain due to increased turbidities during construction and improved long-term habitat after construction.

(3) Effects on Special Aquatic Sites

(a) Mussel Sanctuary. The State of Kentucky classifies the Tennessee River below Kentucky Dam (R.M. 12.0-22.4) as an Outstanding Resource Water. The river from the dam until R.M 17.8 is a designated mussel sanctuary by the State of Kentucky. Because of the significance of the resource, impacts on mussels have been a consideration throughout the project design. Based on hydraulic evaluations and data from the physical model, effects on downstream mussel beds are anticipated to be insignificant. Some minor direct impacts would result from the construction of some features, however, based on mussel survey information this should be minimal.

(4) Threatened and Endangered Species: A supplemental Biological Opinion conducted as part of the March 2000 Highway Relocation EA stated that the project activities are not likely to jeopardize the continued existence of the Indiana bat, orange-footed pearly mussel, or the pink mucket. The Biological Opinion also included a discussion about incidental take of these species and a set of reasonable and prudent measures to minimize those effects. Based on coordination with the U.S. Fish and Wildlife Service (USFWS) throughout the DSEIS development, reinitiation of formal consultation is not anticipated for the features covered in this DSEIS due to the lack of anticipated effects. This determination is subject to concurrence with the USFWS.

(5) Other Wildlife: No significant effect.

(6) Actions That Would Be Taken to Minimize Adverse Impacts Refer to Section II a (5).

f. PROPOSED DISPOSAL SITE DETERMINATION

(1) Mixing Zone Determination With the use of rock fill for the structures covered in this evaluation, the mixing zone should be limited to the immediate area at or downstream of the feature. This should produce minimal effects away from each feature.

(2) Determination of Compliance with Applicable Water Quality Standards: The State of Kentucky's water quality standard would be incorporated into project planning and design. Turbidity levels would be visually monitored downstream of the project during construction, and work limited if unacceptable controls of construction runoff occurred. Any conditions of the Section 401(a) Water Quality Certification from the Kentucky Division of Water will be conditions of this project. Seasonal restrictions on in-stream activity for protection of fish spawning will be incorporated into the project construction schedule.

(3) Potential Effects on Human Use Characteristics

(a) Municipal and Private Water Supply: There are no known municipal or private water supply intakes in the vicinity of the project area.

(b) Recreational and Commercial Fisheries: Recreational fishing is a significant resource for the Tennessee River tailwater. Mitigation proposed in this DSEIS includes offsetting impacts of bank closures during construction. Other features proposed as mitigation for the closure of the TVA campground would provide improved fishing facilities. Commercial fishermen (shad-dipping) utilize the tailwater, primarily the easternmost railroad bridge coffer cell, to dipnet shad for use as catfish bait. The importance of fishing resources was emphasized by the KDFWR early in the scoping process and they have been involved in the design of the various features. As such, the long-term effects of the fill placement for the various structures in the evaluation would be positive. The spillway training dike would improve recreational boating safety and aquatic habitat. The west bank jetties and fishing piers would provide improved fishing opportunities and habitat. Fill associated with the lock facilities would have some minor negative effects but these structures are located in the navigation channel where fishing use is not as critical. Short-term effects would be negative during construction, as some areas would require closure for recreational fishermen.

(c) Water Related Recreation: The primary water related recreation use is fishing. Some areas would be closed during construction. Long-term effects would be positive with the improved facilities for launching boats (west bank basin) and improved fishing conditions with the spillway training dikes. After the new lock is completed, travel time through the locks would be reduced to the benefit of both commercial and recreational traffic on the lake and tailwater.

(d) Aesthetics: Long-term aesthetics would not be affected with the exception of less congestion as commercial traffic passes through the lock in less time. Short-term construction impacts would be minor but negative.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves: Long term effects would be positive with improved facilities for the Kentucky Dam Village State Park and the TVA Powerhouse Island. The west bank boat basin and fishing jetties would be in the former. The short-term effects would be negative during construction as areas are closed for public safety. These closures are to be staged to allow ample public areas to be available and to provide areas to mitigate for upstream bank closures prior to the actual closure.

g. Determination of Cumulative Effects on the Aquatic Ecosystems: The placement of fill for the features covered in this evaluation (and DSEIS) would result in positive cumulative impacts on aquatic ecosystems. The dikes and fishing jetties would provide improved habitat. Potential negative effects, such as alteration of flow patterns on downstream mussel beds, are not anticipated based on the evaluations documented in the DSEIS.

h. Determination of the Secondary Effects on the Aquatic Ecosystem. Secondary effects are not significant. Some slight benefits would be seen after the new lock and the navigation training dike are completed, as barges no longer nose into downstream banks during times when lock traffic is backlogged.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

(a) ADAPTATION OF THE SECTION 404(B)(1) GUIDELINES TO THIS EVALUATION

No significant adaptations of the Section 404(b)(1) guidelines were made relative to this evaluation.

(b) EVALUATION OF AVAILABILITY OF PRACTICABLE ALTERNATIVES TO THE PROPOSED DISCHARGE SITE WHICH WOULD HAVE LESS ADVERSE IMPACT ON THE AQUATIC ECOSYSTEM

For the spillway and navigation training dikes, physical modeling was performed to determine the minimum size structure that met the goal of improving river flow patterns while not impacting other resources. There is no feasible alternative to fill placement for lock walls, although, the area impacted by the downstream coffercell has been drastically reduced. The use of floating lock walls will reduce the fill associated with these structures.

(c) COMPLIANCE WITH APPLICABLE STATE WATER QUALITY STANDARDS

Compliance with the Kentucky water quality standards would be maintained and monitored. The USACE - Nashville District has requested Kentucky 401 Water Quality Certification for this project as part of the normal permitting process.

(d) COMPLIANCE WITH TOXIC EFFLUENT STANDARD OR PROHIBITION UNDER SECTION 307 OF THE CLEAN WATER ACT: Complies

(e) COMPLIANCE WITH THE ENDANGERED SPECIES ACT OF 1973

The supplemental Biological Opinion performed for the March 2000 Highway Relocation EA states that the USFWS had concluded that the relocation of the highway is not likely to jeopardize the continued existence of the Indiana bat, orange-footed pearly mussel, or the pink mucket. The Biological Opinion also included a discussion about incidental take of these species and a set of reasonable and prudent measures to minimize those effects. Throughout conductance of the DSEIS, impacts to federally listed species were considered. Based on coordination to date, reinitiation of the formal consultation for features covered in this evaluation (and DSEIS) is not anticipated. This determination is to approval by the USFWS.

(f) COMPLIANCE WITH SPECIFIED PROTECTION MEASURES FOR MARINE SANCTUARIES DESIGNATED BY THE MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT OF 1972: **Not applicable.**

(g) EVALUATION OF EXTENT OF DEGRADATION OF THE WATERS OF THE UNITED STATES

(1) Significant Adverse Effects on Human Health and Welfare

a. Municipal and private water supply: The proposed action should not have any significant adverse effects.

b. Recreational and commercial fisheries: The proposed action should not have any significant adverse effects.

c. Plankton: The proposed action should not have any significant adverse effects.

d. Fish: The proposed action should not have any significant adverse effects.

e. Shellfish: The proposed action should not have any significant adverse effects, including downstream mussel beds. Mussel relocation would be performed in areas affected by the west bank fishing jetties and in the navigation channel and considered for other areas where warranted and feasible from a diver safety standpoint.

f. Wildlife: The proposed action should not have any significant adverse effects.

g. Special aquatic sites: The proposed action should not have any significant adverse effects on the Tennessee River mussel sanctuary.

(2) Significant Adverse Impacts on Life Stages of Aquatic Life and Other Wildlife Dependent on Aquatic Ecosystems: The proposed action would have no significant adverse impacts on life stages of aquatic life and other wildlife dependent on aquatic ecosystems.

(3) Significant Adverse Impacts on Aquatic Ecosystem Diversity, Productivity, and Diversity: The proposed action would have no significant adverse impacts on aquatic ecosystem diversity, productivity, and diversity.

(4) Significant Adverse Impacts on Recreational, Aesthetic, and Economic Values: The proposed action would have no significant adverse impacts on recreational, aesthetic, or economic values.

h. APPROPRIATE AND PRACTICABLE STEPS TAKEN TO MINIMIZE POTENTIAL ADVERSE IMPACTS OF THE DISCHARGE ON THE AQUATIC ECOSYSTEM

- Clean rock fill would be used for the fill placement with minimal content of fines. The rock would be sized to prevent movement of the structures during high flow conditions.
- Seasonal restrictions on in-stream activities would be followed per the 401 water quality certification to protect fish spawning beds
- Mussel relocation is proposed for the footprint of the west bank fishing jetties and in areas affected in the navigation channel.

i. ON THE BASIS OF THE GUIDELINES, THE PROPOSED DISPOSAL SITES FOR THE DISCHARGE OF DREDGED OR FILL MATERIAL IS

(1) Specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

Timothy A. Higgs
8-31-01

Timothy A. Higgs
Environmental Engineer
Project Planning Branch

Table 1
Features Requiring Fill Placement Below OHW – 404(b)(1) Evaluation

Feature	Item # (refer to Fig.2)	Fill Volume (CY)	Purpose	HW /TW	Size Ft^2
Access Road to Existing Riverward Lockwall	14	1440	Lock Access During Construction	HW	700
Upstream Approach Wall	10	800	New Lock	HW	500
Upstream Coffercell Revised 1-15-02 for Temp Causeway for Grouting	9	1250	New Lock Construction	HW	7500
Downstream Approach Wall & Slurry Wall	8	1900	New Lock	TW	12800
Downstream Coffercell	8	8600	New Lock Construction	TW	17900
Navigation Training Dike	6	2689	Improve Commercial Navigation	TW	5355
Spillway Training Dikes	12	94500	Improve Recreational Boating Safety	TW	146583
West Bank Fishing Jetties (Total for both jetties)	3	9510	Mitigate for lost fishing access/ bank closures	TW	32,652
West Bank Boat Basin	2	NA	Bank Stabilization in expanded basin	TW	NA

Headwater (HW) - Normal Summer Pool 359'
Tailwater (TW) - Normal Pool 302'

(Rohrbach, 2949)

MEMORANDUM FOR Record

PROJECT Kentucky Lock Addition

SUBJECT Temporary Fill for Placement at Taylor Park Campground

1) As part of the Kentucky Lock Addition project, it is proposed to utilize the lower level of Taylor Park Campground as a stockpile area for material that will be excavated during construction. This memorandum will describe pertinent details of this fill placement in regards to impacts to pool storage within the Kentucky Reservoir.

2) **Background.** Taylor Park Campground is a TVA facility that is located just upstream and adjacent to the existing KY Lock. The campground was identified as a contractor laydown area in the 1992 EIS for the KY Lock project. It has been closed to the public for the last two years. The lower level comprises about 10.8acres and ranges in elevation from approximately 355 near water's edge to approximately 365 at a point farthest from the water. The 1.9 acres of the upper level of the campground is nearly level at an elevation of 385. All of the proposed fill placement will be in the lower level of the campground. Most of the material to be placed will be temporary in nature – it is planned to use most of the material as backfill during the final phases of lock construction (anticipated to be near 2007). The ultimate configuration of the lower level will be dictated by TVA needs/plans for this area upon project completion. For example, a small amount of material may remain in the lower level to reduce the frequency of its inundation.

3) **Immediate Plans.** During November and December 2000, it is proposed to place fill in the lower level of Taylor Park Campground to facilitate construction of storage pads for cofferdam sheet piling that will be arriving from the Olmsted Lock and Dam Project as early as January 2001. The majority of this fill will be obtained from Vulcan Materials during the removal of their jetty in the interior of their harbor (adjacent to the campground). Approximately 31,137 CY of material (mainly rock) will be removed by Vulcan between Kentucky Lake Pool elevations 354 and 375, and 60,252 CY of material below elevation 354. Only 8,000 CY of this material is proposed to be placed between elevations 359 and 375 within the campground. The remaining material removed by Vulcan will be transported to their upland disposal site. The fill in the campground makes it feasible to store the sheetpile at this location and significantly reduces the cost to the Government of alternate sites that would require double handling of the sheetpile and would require longer travel distances.

In addition to the storage pads above, an approach basin is proposed to be dredged adjacent to the campground to facilitate offloading of the sheetpile from the transport barges. Dredging for this approach basin will occur in an area approximately 200 ft wide along the bank and beginning approximately 75 ft from the water's edge (at EL 355.2) to within approximately 25 ft of the water's edge. The area would be dredged to EL 345.0. This will allow a clear 9' depth at the normal winter pool of EL 354.0. The approximate quantity to be dredged and placed in the campground is 1450 cubic yards. This dredged material is expected to be granular in nature, will be contained by rock dikes, and is expected to drain readily.

4) **Long-term plans.** During excavation for the Upstream Cofferdam and the new lock (beginning in the summer of 2001), it is proposed to place as much as 125,000 CY of material between elevations 359 and 375 in the campground. Even though a large quantity of this material will be excavated below elevation 375, its displaced volume will not be available for water storage since the upstream cofferdam will block lake water from entering the excavated area. Therefore, the net loss of lake storage above elevation 359 will be greater than the 147,500 CY (125 + 8 + 14.5k) placed in the campground (i.e., by its position, the upstream cofferdam reduces existing lake storage). Upon completion of the new lock and removal of the upstream cofferdam, additional lake storage will be provided as compared to existing conditions.

5) **Alternatives to fill in Taylor Park Campground.** The most practical alternative to temporarily placing fill in the campground is to haul this material to the main KY Lock designated disposal site, located approximately 1.5 miles from the project site. The reasons the campground disposal is preferred are:

- The cost to the Government will be significantly lower due to the much longer haul distance to the alternate disposal site. This is figured for the 400,000 CY of material that could ultimately be stockpiled at this site. This high storage volume is due to volume above elevation 375 and due to two stockpile periods during lock construction (i.e., the campground will be filled then emptied, then filled again, and then emptied).
- Contractor laydown area is at a premium at this site. Stockpiling material in the campground creates flood-free land suitable for many construction uses. This will minimize incursions into adjacent TVA and Corps operation and maintenance activities/compounds.
- The storage impacts to the reservoir appear to be insignificant and are temporary in nature. They are also partially offset by the jetty removal by Vulcan.

Benjamin L. Rohrbach
Civil/Hydraulic Engineer
CELRN-EC-H

(Rohrbach, 2949)

MEMORANDUM FOR Record

PROJECT Kentucky Lock Addition

SUBJECT Impacts to Headwater and Tailwater Flooding Due to Proposed Features of Lock Addition

This memorandum addresses the primary concerns at this moment with regards to post project flood conditions in both the headwater and tailwater at the project site.

1) Proposed temporary fill placement in Taylor Park Campground, to the east of the existing lock and upstream, has been addressed in detail in a separate memorandum, issued by Benjamin L. Rohrbach, dated 16 November, 2000. The Tennessee Valley Authority has issued a "Letter of No Objection" regarding placement of fill in the floodplain at TPC.

According to the details of the subject memorandum, the fill placed in TPC will have the effect of reducing the storage capacity of the KY Lake reservoir during the period in which it remains. The total anticipated volume is approximately 400,000 CY over the life of the construction project, with approximately 147,500 CY in place at any given time. The flood storage pool for Kentucky Lake encompasses 4,008,000 ac.-ft., or 6,466,240,000 CY. The fill proposed for TPC represents a fraction (.000023%) of the total flood storage capacity. Thus, the effect upon flood elevations will be insignificant.

At completion, after removal of the stockpiled material and cellular cofferdams, the total reservoir volume will increase. Exact figures have not been calculated, but it is anticipated that any fill remaining in TPC, to raise the level of useable area, will be considerably less than the additional volume provided by the new lock approach excavation and the volume upstream of the new gate pintles that was formerly behind the cofferdam.

2) In the East Bank tailwater area, construction of the Vulcan Disposal Area haul road will result in approximately 28,000 CY of permanent fill being placed below the 100 year flood plain elevation of 346.6’, along the east bank of the lower tailrace and extending up the Russel Creek Tributary.

Fill placement for construction of the haul road is anticipated to begin at TRM 21.5 and end at TRM 22.0, as measured perpendicular to the centerline of the river.

3) In the West Bank tailwater area, fill associated with construction of the relocated RR and Hwy embankments and WB disposal area will be partially offset by enlargement of the boat basin. The volume of fill associated with construction of the relocated RR is equal to 192,500 CY. The volume of fill associated with construction of the relocated Hwy is equal to 112,000 CY. The WB disposal area is anticipated to reach a volume equal to 253,500 CY. The floodplain storage area gained by enlargement of the boat basin is equal to 139,000 CY. Thus, the net WB fill is equal to 419,000 CY.

4) Construction activities in the TW below Kentucky Dam are limited to the area between the embankment face and TRM 21.5. Typical cross sections of this area were taken from an HEC RAS model of the KY tailwater created by Charles Irwin, dated 06 January 1999. These sections show that the volume of the shape bounded by the 100 year flood plain elevation of 346.6’ and the river sections at the embankment face and TRM 21.5 is approximately 22,493,071 CY. The total anticipated fill placement in the TW, both East Bank and West Bank, is approximately equal to 447,000 CY.

Numerical modeling of TW conditions after construction of the RR and HWY embankments has been conducted. This analysis was performed by Charlie Irwin, with results presented in Memorandum for Record dated 5 January, 1999. The memorandum concluded that the backwater impacts to the Kentucky Dam Powerhouse from the proposed Railroad and Highway Bridges are minimal.

The proposed fill in the TW area, excluding the RR and Hwy embankment fill, between the dam embankment and TRM 21.5, below elevation 346.6’, is equal to 114,500 CY. This represents .0051% of the volume of the floodplain. Most of the fill will be occurring in flood storage areas not part of the active conveyance, thus having a lesser impact on the flood heights. Detailed analyses of the fill impacts via hydraulic model are not necessary given these considerations. The conclusion to be drawn is that construction of TW improvements will not have a significant impact upon the post construction flood elevations in the project tailwater.

5) Construction of various dikes and training structures in the tailwater below Kentucky Dam will have little or no impact upon flood heights even though these structures are located in areas of active conveyance. The total volume proposed for placement (including spillway training dikes, navigation training dike, and west bank fishing jetties) is approximately 110,000 CY. Water surface elevations obtained from the 1:100 scale physical model constructed at the Waterways Experiment Station, before and after placement of the subject structures, show water surface elevation increases of no more than .3’ under a wide range of TW elevations and discharges. The maximum increases were obtained for conditions with a low TW elevation and high discharge (100,000 cfs discharge, TW = 306.3’) and appear to be directly related to incorporation of the spillway dikes in the model. Elevation differences for all other TW conditions analyzed were less than .2’. Numerical modeling of the effect of these dike structures is not considered necessary considering the ability to collect data directly from the physical model.

Benjamin L. Rohrbach
Civil/Hydraulic Engineer
CELRN-EC-H

(Rohrbach/2949)

MEMORANDUM FOR: Record

PROJECT: KY Lock Addition

SUBJECT: Water Surface Elevation Impacts Due to Placement of Training Structures in KY Dam Tailwater

1. Placement of training structures in the tailwater below Kentucky Lock and Dam have resulted in water surface profiles that vary from those measured under Base Conditions.

2. The following tables contain water surface elevations obtained at specific locations in the 1:100 scale physical model under a wide range of TW conditions, for all plans. Actual water surface elevations for Base Conditions are listed with water surface elevation differences reported for the other plans.

35,000 CFS 359.0 HW 300.0 TW

Gage No.	BASE	PLAN B	PLAN B-2	PLAN C
1	359.0	0.0	0.0	0.0
2L	300.1	0.0	0.0	0.0
2R	300.2	-0.1	-0.1	-0.1
3L	300.1	0.1	0.0	0.1
3R	300.1	0.1	0.1	0.0
4*	300.0	0.1	0.1	0.1
5L	300.1	0.0	0.0	-0.1
5R	300.1	0.0	-0.1	-0.1
6	300.1	-0.1	0.0	-0.1
7	300.1	-0.1	-0.1	-0.1
8	299.9	-0.1	-0.1	-0.1
9**	299.7	0.0	0.0	0.0

79,000 CFS 359.0 HW 303.6 TW

Gage No.	BASE	PLAN B	PLAN B-2	PLAN C
1	359.0	0.0	0.0	0.0
2L	303.5	-0.1	0.0	0.1
2R	303.4	0.0	0.1	0.1
3L	303.5	0.0	0.1	0.2
3R	303.6	0.0	0.1	0.1
4*	303.6	-0.2	-0.1	-0.1
5L	303.6	0.0	0.0	0.0
5R	303.4	0.0	0.0	0.0
6	303.4	0.0	0.1	0.0
7	303.2	-0.1	0.1	0.1
8	302.9	-0.2	0.0	0.0
9**	302.5	0.0	0.0	0.0

100,000 CFS 358.0 HW 306.3 TW

Gage No.	BASE	PLAN B	PLAN B-2	PLAN C
1	358.0	0.0	0.0	0.0
2L	306.2	0.1	0.0	0.2
2R	306.4	0.0	-0.1	0.3
3L	306.2	0.2	0.0	0.2
3R	306.3	0.2	0.0	0.3
4*	306.3	0.0	-0.1	0.0
5L	306.2	0.3	0.1	0.0
5R	306.2	0.1	-0.1	0.0
6	306.1	0.1	0.0	0.1
7	306.0	0.1	-0.1	0.1
8	305.7	0.0	-0.2	0.0
9**	305.4	0.0	0.0	0.0

155,000 CFS 359.0 HW 316.0 TW

Gage No.	BASE	PLAN B	PLAN B-2	PLAN C
1	359.0	0.0	0.0	0.0
2L	316.1	-0.2	-0.2	-0.1
2R	316.2	0.0	-0.1	0.1
3L	316.1	0.1	-0.1	0.1
3R	316.1	0.1	0.0	0.2
4*	316.0	-0.1	-0.1	0.0
5L	315.9	0.0	-0.1	0.0
5R	315.9	0.0	-0.1	0.0
6	315.8	0.0	0.0	0.0
7	315.7	0.0	0.0	0.0
8	315.5	-0.1	0.0	0.0
9**	315.4	0.0	0.0	0.0

300,000 CFS 362.5 HW 328.0 TW

Gage No.	BASE	PLAN B	PLAN B-2	PLAN C
1	362.5	0.0	0.0	0.0
2L	328.2	0.2	-0.2	0.1
2R	328.2	0.2	-0.1	0.2
3L	328.3	0.1	-0.3	0.0
3R	328.2	0.1	0.0	0.2
4*	328.0	0.2	0.0	0.1
5L	328.0	0.1	-0.2	0.0
5R	328.0	0.1	-0.2	0.0
6	327.9	0.2	-0.1	0.1
7	327.7	0.2	-0.1	0.1
8	327.5	0.1	-0.2	0.0
9**	327.3	0.0	0.0	0.0

370,000 CFS 368.3 HW 344.0 TW

Gage No.	BASE	PLAN B	PLAN B-2	PLAN C
1	368.3	0.0	0.0	0.0
2L	344.1	-0.1	0.0	0.0
2R	344.0	0.0	0.1	0.1
3L	344.1	-0.1	0.0	-0.1
3R	344.1	0.0	0.0	0.0
4*	344.0	0.0	0.1	0.0
5L	344.0	0.0	0.0	0.0
5R	343.9	0.1	0.1	0.1
6	343.9	0.0	0.1	0.1
7	343.8	0.1	0.1	0.1
8	343.7	-0.1	0.0	0.0
9**	343.6	0.0	0.0	0.0

* - Water surface controlled at this gage during Base Conditions, establishing tailwater elevation at gage 9

** Water surface controlled at this gage during plan conditions to allow water surface in model to vary with pla condition installed

3. From the above tables, it can be seen that the maximum water surface elevation increases occur under the 100,000 cfs discharge and 306.3’ TW conditions. Water surface elevation increases of 0.3’ from Base Conditions to Plan C occur at gage points 3R and 2R. These gages are located along the WB of the powerhouse island with gage 2R being just upstream of the old RR cells and gage 3R upstream of the new RR/Hwy alignments.

4. Water surface elevations at gages 3R and 2R are unchanged from Base Conditions to Plan B-2, suggesting that the elevation changes discussed above are directly related to installation of the Plan C spillway training dikes.

Benjamin L. Rohrbach
Civil/Hydraulic Engineer
CELRN-EC-H

Item 7

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO

Project Management Branch

SEP 15 2000

Mr. John Dovak
Kentucky Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Dear Mr. Dovak:

On March 16, 2000, your office re-issued to the Corps of Engineers a Water Quality Certification (WQC #1998-0016-1) for the Kentucky Lock Addition Project at TRM #22.4, including the relocation of US 62 and P&L Railroad Bridges over the Tennessee River. The project will impact 7.0 acres of forested wetlands. The certification included a restriction against working within the existing wetlands until a wetland mitigation plan for a minimum 14 acre site was approved by the Division of Water (DOW).

On September 7, 2000, a site visit was made to a proposed mitigation site near Benton, Kentucky to discuss the suitability of the site for mitigation. In addition to the Corps and its contractor, attending this site visit were Ed Carroll of the DOW, Tim Merritt of the U.S. Fish and Wildlife Service, Kevin Tucker of the Kentucky Department of Fish and Wildlife Resources, and Rick Huffines of the Clarks River National Wildlife Refuge. All were in agreement with the conceptual mitigation plan and we are now proceeding with purchase of this property by the Tennessee Valley Authority. We have reached a negotiated price with the landowners and hope to have the property acquired within a few weeks.

As discussed with Ed Carroll during the site visit, we are submitting an initial mitigation plan (copy enclosed) for your review. I will furnish additional information such as detailed drawings of water control structures at a later date. The proposed mitigation site is 25 acres and will consist of 15.1 acres of mitigated (prior-converted) wetlands, 1.2 acres of open-water, and 9 acres of existing wetlands. The existing wetlands adjoin the Clarks River National Wildlife Refuge and the Corps is discussing incorporation of this site into the refuge in the future. The mitigated wetlands will be planted with mast-producing trees.

I am requesting a lifting of the WQC restriction against working in the existing wetlands at Kentucky Dam based on this submittal. This would allow our west bank embankment contractor to begin extensive work at Kentucky Dam during the typically-drier Fall months. Contact Tim Higgs at (615) 736-7192 or myself at 736-2346 if you have any comments or require additional information.

Sincerely,

Don Getty
Project Manager
Kentucky Lock Addition

Enclosure

CF:
Ed Carroll (KDOW-Madisonville)
Bob Bay (USFWS)

JAMES E. BICKFORD
SECRETARY

PAUL E. PATTON
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
MADISONVILLE REGIONAL OFFICE
MADISONVILLE STATE OFFICE BUILDING
625 HOSPITAL DR.
MADISONVILLE KY 42431-1683

(270) 824-7529

10/13/00

Don Getty
Project Planning Branch
USACOE
P O Box 1070
Nashville, TN 37202

RE: Water Quality Certification # 1998-0016-1, Kentucky Lock Addition Project.

Dear Mr. Getty,

The WQC for the Kentucky Dam Lock Addition Project specifies a work restriction that prohibits work in the on-site wetland until approval by this agency of a wetland mitigation plan. I have received an initial mitigation plan from your office.

Based on the information contained in this initial mitigation plan I am reasonably assured that the mitigation will be completed successfully. I have discussed this issue with my supervisor, John Dovak, and we concur that work may begin in the on-site wetland at your discretion. To ensure continued dialog I am requesting that you contact this office before the close of the calendar year with an update regarding land acquisition for the proposed mitigation.

If you have any question please contact this office.

Sincerely,
Edward W. Carroll
Edward W. Carroll
Environmental Biologist III

Proposed Compensatory Wetlands Mitigation Plan
Benton, Kentucky

Project: Proposed Lock Addition Project at Kentucky Dam including Relocation of the U.S. Highway 62 and 641 and the Paducah and Louisville Railroad Crossing of the Tennessee River.

Mitigation Objective: To replace forested wetlands functions impacted by the proposed railroad and highway relocation with higher quality and greater functioning wetlands.

Existing Impacted Wetlands: Wetlands impacted by the proposed project consist of about 7.0 acres of palustrine forested and emergent wetlands. About 5.7 acres of forested wetlands consist primarily of small depressional areas within a larger tract of upland forest. This area will be impacted by the P&L Railroad relocation and is identified as Area W-2 in the Environmental Assessment (EA). The proposed highway relocation will impact about 1.0 acre of forested wetlands within Area W-1 (shown in the EA). In addition, about 0.25 acres of emergent wetlands will be impacted by highway construction for the Russell Creek crossing.

The impacted wetlands provide few functions due to their small size. Wetland functions might include seasonal wildlife habitat, primarily for amphibians, and very limited sediment retention and nutrient cycling functions. The dominant tree species within these wetland areas include river birch (Betula nigra), sweet gum (Liquidambar styraciflua), red maple (Acer rubrum), black willow (Salix nigra), black locust (Robinia pseudoacacia) and sycamore (Plantanus occidentalis). Emergent species include cattail (Typha latifolia), soft rush (Juncus effuses), broom-sedge (Andropogon virginicus), false nettle (Boehmeria cylindrical), Virginia button weed (Diodia virginiana), Nepal grass (Microstegium vimineum), and poison ivy (Toxicodendron radicans).

Mitigation Replacement Ratio: A replacement ratio of 2:1 has been proposed for this project. Impacted wetlands, including upland forest, constitute about 7.0 acres. At a 2:1 replacement ratio, the wetlands compensation acreage required will be 14.0 acres.

Proposed Compensation: The U.S. Army Corps of Engineers and the Tennessee Valley Authority (TVA) is proposing to purchase a 25 acre parcel in Benton, Kentucky to compensate for impacts to 14.0 acres of jurisdictional wetlands. This parcel is adjacent to a portion of the U.S. Fish and Wildlife Service's Clark's River National Wildlife Refuge. About 8.7 acres of the site consists of existing emergent and forested wetlands. The remaining 16.3 acres consists of a 1.2 acre open water pond and 15.1 acres of fallow agricultural land. This agricultural land has been designated as Prior-converted cropland by the Natural Resources Conservation Service. The County soil survey depicts the soil types on the site as predominately Waverly silt loam with Falaya silt loam occurring at slightly higher elevations. Waverly silt loam is considered to be a hydric soil within the county and Falaya silt loam contains hydric inclusions of Waverly and Bibb silt loam.

Proposed Wetlands Plan: About 15.1 acres of old field growth will be reverted to forested and emergent wetlands. In addition, the 1.2 acre open water pond and the 8.7 acres of existing wetlands will be placed in a permanent conservation easement to protect these areas from future development.

Currently, a ditch extends through the parcel effectively draining the agricultural portion of the site. The Corps and TVA propose placing riprap check dams across the ditch to restore hydrology throughout the site. Check dams will be placed at locations necessary to allow surface water sheet flow across the site restoring previous hydrologic conditions. Water control structures such as low profile earthen berms will be placed along adjacent property lines to ensure that flooding does not occur on neighboring property. The attached figure of the proposed design depicts preliminary locations of the check dams, these locations are subject to modification. Detailed drawings of the check dams and other water control structures along with their precise locations will be provided in the project plans and specifications. This design will alleviate the need for larger berms or excavation to achieve wetland hydrology. It is anticipated that a change in hydrology, or restoration, will allow a succession of emergent hydrophytes from adjacent seed sources to re-colonize the site.

Trees will also be planted within this 15.1 acre tract to replace the forested wetlands impacted by the proposed project. Tree species including: Pin Oak (Quercus palustris); Shellbark Hickory (Carya laciniosa); Bur Oak (Quercus macrocarpa); and Swamp Chestnut Oak (Quercus michauxii) will be planted in equal proportions on 10 foot centers which equates to about 436 trees per acre. In addition, bald cypress (Taxodium distichum) will be plant around the perimeter of the open water pond approximately every 15 feet. Therefore, about 6,688 trees will be planted.

The tree species selected have been recommended in the Wetland Compensatory Mitigation and Monitoring Plan Guidelines for Kentucky for the proposed hydrologic regime of the site. These tree species, except bald cypress, are hard mast producing species which will provide a valuable food resource for wildlife. The Corps and TVA have proposed to dedicate the entire 25.0 acre parcel to the U.S. Fish and Wildlife Service as an addition to the Clark's River National Wildlife Refuge. TVA will maintain ownership and monitoring of the site until the property is transferred to the U.S. Fish & Wildlife Service, (contingent upon their approval).

Monitoring Plan: Monitoring will be implemented upon completion of the wetlands compensation site construction. The monitoring plan will ensure that project goals and permit conditions are being met. The monitoring program will also determine if the planting and hydrological components of the compensation plan are functioning as planned. The monitoring plan will follow the guidelines established in the Wetland Compensation Mitigation and Monitoring Plan Guidelines for Kentucky.

The monitoring program will continue bi-annually until two consecutive years of successfully achieving the performance standards are met. Monitoring will continue annually thereafter for five years after project construction. An annual report will be prepared to document the condition of the wetlands compensation site. This report will be sent to interested resource agencies. The report will include photographic documentation of the site taken at the same location from all four cardinal directions and during the same time of year, during the growing season. A quantitative survey of the planted species' survival rates will be determined. If required survival rates are not achieved, the probable cause of failure will be indicated (i.e., pests, predation, inadequate hydrology, disease, invasion of non-native plant species, etc.). The hydrologic conditions at the site, such as the extent and depth of inundation or saturation will be noted along with the rainfall recorded for the area for the preceding year. Direct sightings and indirect signs of wildlife use of the area (i.e., tracks, nests, etc.) will be noted. Any other observations relating to the compensation site will be noted in the annual report such as siltation, erosion, predation, etc.

Annual performance standards are included in this plan and will be used to measure progress towards the project goals. The attainment or non-attainment of performance standards will be assessed by monitoring. Non-attainment will indicate the need for remediation. The U.S. Army Corps of Engineers or their designee will monitor the site and will forward the monitoring reports to the resource agencies for their review. The site will be monitored for five years after completion.

The following are performance standards for determining success of the created wetlands:

1. Land cleared for site preparation will be seeded with a temporary grass cover immediately following completion of the earthwork activities. The project will require coverage of at least 75 percent of the disturbed area within three (3) weeks.

2. Following the period of establishment, 100 percent of the planted trees should be alive and healthy. At the end of the five year monitoring period 80 percent of the planted trees must be live and healthy.

3. At the end of the five year monitoring period, at least 50 percent of the wetland area should be covered by the approved planted species. No single species should constitute greater than 25 percent of the surviving species.

4. None of the three most dominant plant species may be non-native species.

5. In at least two out of five years, there should be apparent surface water inundation or saturation present during continuous days for five to 12.5 percent of the growing season. Organic matter in the soils should increase over time.

6. Five years following construction, the site should meet the federal definition of jurisdictional wetlands and the site should classify as forested wetlands based on the Cowardin classification system.

7. The wetland functions and values will be comparable or better than the impacted wetlands functions.

8. The site will meet the Kentucky Water Quality Standards.

Monitoring reports will include the following information:

1. Soils. Soil horizons will be identified and thickness, color, texture, structure, consistency, and boundary will be described. In addition, any gleying, oxidized rhizospheres or other redoximorphic features will be described. Organic matter in the soils will also be recorded.

2. Hydrology. Monitoring should include precipitation data for the current year including cumulative rainfall compared to the yearly average. This data should be obtained from the nearest weather station to the compenstion sites. Surface water will be recorded after each inundation event during the growing season and groundwater will be recorded every 9 days from March 15 through June 30 and monthly thereafter for the remainder of the growing season.

3. Vegetation. The wetlands compensation site will be monitored for vegetation. A plant list, with dominant species and indicator status identified, will be compiled for each vegetative cover type. The survival rate of the planted species will be determined and the ratio of planted species to volunteer species will be calculated. A standard ecological method will be used to quantify the dominant plant species in each of the cover types. Quadrants 4 m by 4 m for the shrub/sapling layer and 1 m by 1 m for the herbaceous layer will be used.

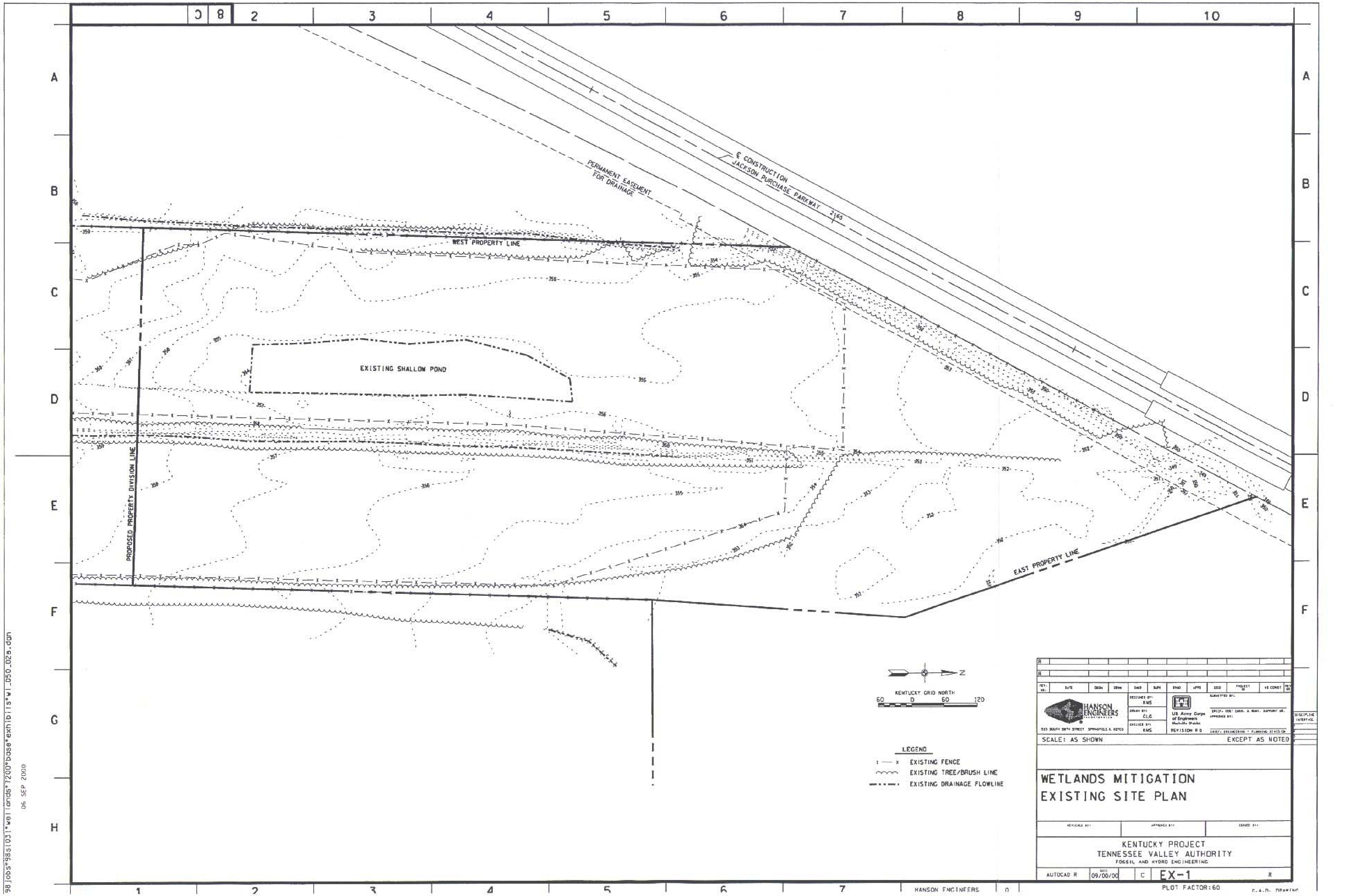
   Live trees and shrubs within the created wetlands will be counted. The height and diameter (at breast heights) of all planted trees should be measured and then averaged by species.

4. Permanent photo stations will be established at each site. Photographs at each photo station will be taken in each of the four cardinal directions for each cover type during every monitoring site visit.

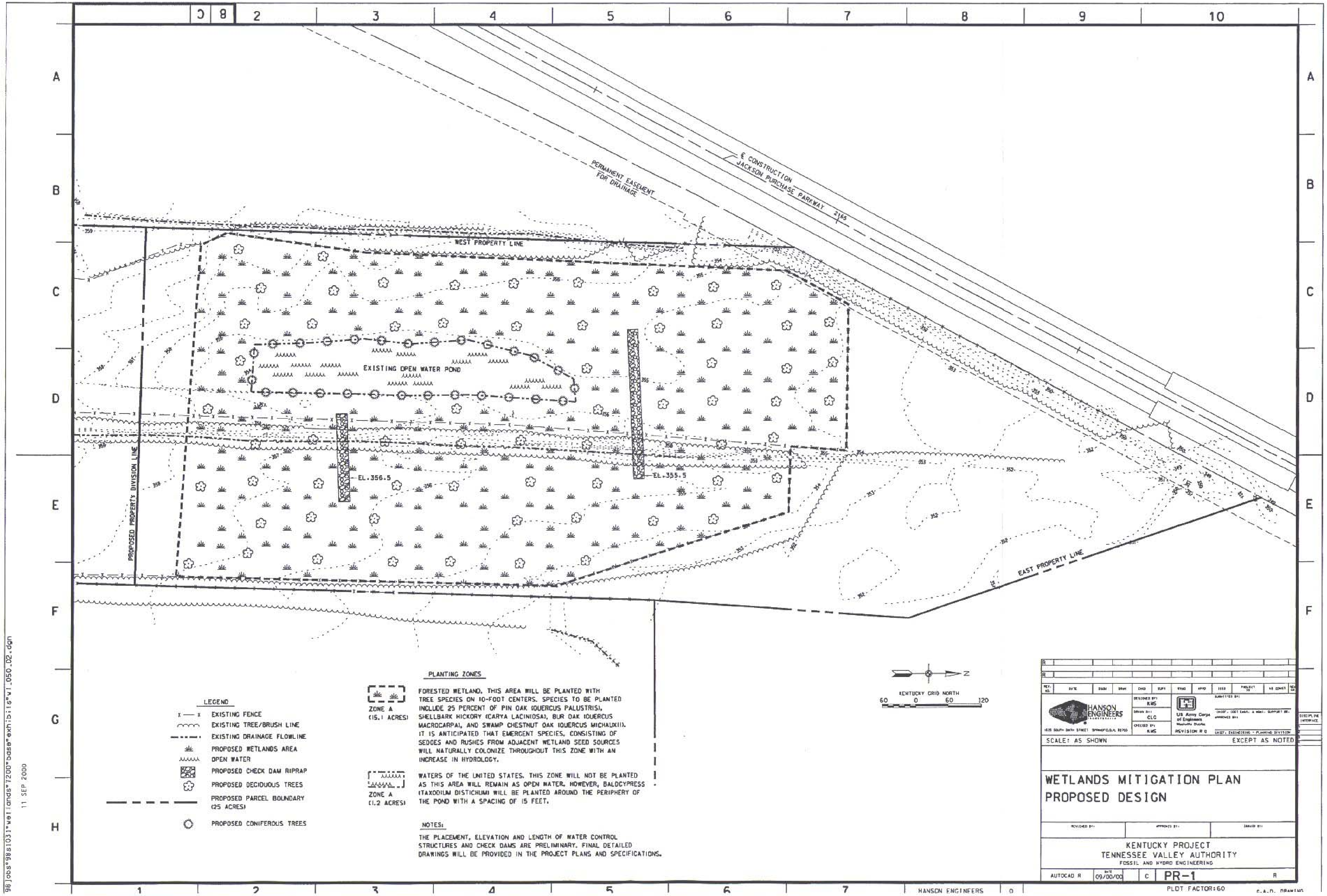
5. The monitoring reports will be conducted by qualified individuals and names, addresses, and phone numbers for each person responsible for sampling will be included in the reports.

Management of tree plantings through the end of the period of establishment will be the responsibility of the Contractor. Large colonies of noxious weeds will be controlled; especially around plantings. Mowing and herbicides may be used to control noxious vegetation.

The U.S. Army Corps of Engineers will transfer title to the land to the U.S. Fish and Wildlife Service (based on their approval), and they will manage the site in perpetuity. The site will be managed with the intent of achieving and maintaining the goals and objectives described in this plan.



℄ CONSTRUCTION
JACKSON PURCHASE PARKWAY
PERMANENT EASEMENT FOR DRAINAGE
WEST PROPERTY LINE
EXISTING SHALLOW POND
PROPOSED PROPERTY DIVISION LINE
EAST PROPERTY LINE
KENTUCKY GRID NORTH
60 0 60 120
LEGEND
EXISTING FENCE
EXISTING TREE/BRUSH LINE
EXISTING DRAINAGE FLOWLINE
HANSON ENGINEERS
US Army Corps of Engineers
SCALE: AS SHOWN
EXCEPT AS NOTED
WETLANDS MITIGATION
EXISTING SITE PLAN
KENTUCKY PROJECT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
AUTOCAD R
09/00/00
EX-1
PLOT FACTOR:60
06 SEP 2000



PERMANENT EASEMENT FOR DRAINAGE
℄ CONSTRUCTION JACKSON PURCHASE PARKWAY
WEST PROPERTY LINE
EXISTING OPEN WATER POND
EL.356.5
EL.355.5
PROPOSED PROPERTY DIVISION LINE
EAST PROPERTY LINE
KENTUCKY GRID NORTH
60 0 60 120
LEGEND
EXISTING FENCE
EXISTING TREE/BRUSH LINE
EXISTING DRAINAGE FLOWLINE
PROPOSED WETLANDS AREA
OPEN WATER
PROPOSED CHECK DAM RIPRAP
PROPOSED DECIDUOUS TREES
PROPOSED PARCEL BOUNDARY (25 ACRES)
PROPOSED CONIFEROUS TREES
PLANTING ZONES
ZONE A (15.1 ACRES)
FORESTED WETLAND. THIS AREA WILL BE PLANTED WITH TREE SPECIES ON 10-FOOT CENTERS. SPECIES TO BE PLANTED INCLUDE 25 PERCENT OF PIN OAK (QUERCUS PALUSTRIS), SHELLBARK HICKORY (CARYA LACINIOSA), BUR OAK (QUERCUS MACROCARPA), AND SWAMP CHESTNUT OAK (QUERCUS MICHAUXII). IT IS ANTICIPATED THAT EMERGENT SPECIES, CONSISTING OF SEDGES AND RUSHES FROM ADJACENT WETLAND SEED SOURCES WILL NATURALLY COLONIZE THROUGHOUT THIS ZONE WITH AN INCREASE IN HYDROLOGY.
ZONE A (1.2 ACRES)
WATERS OF THE UNITED STATES. THIS ZONE WILL NOT BE PLANTED AS THIS AREA WILL REMAIN AS OPEN WATER. HOWEVER, BALDCYPRESS (TAXODIUM DISTICHUM) WILL BE PLANTED AROUND THE PERIPHERY OF THE POND WITH A SPACING OF 15 FEET.
NOTES:
THE PLACEMENT, ELEVATION AND LENGTH OF WATER CONTROL STRUCTURES AND CHECK DAMS ARE PRELIMINARY. FINAL DETAILED DRAWINGS WILL BE PROVIDED IN THE PROJECT PLANS AND SPECIFICATIONS.
HANSON ENGINEERS
DESIGNED BY: KMS
DRAWN BY: CLG
CHECKED BY: KMS
US Army Corps of Engineers
SCALE: AS SHOWN
EXCEPT AS NOTED
WETLANDS MITIGATION PLAN
PROPOSED DESIGN
KENTUCKY PROJECT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
AUTOCAD R
09/00/00
C
PR-1
PLOT FACTOR:60
11 SEP 2000